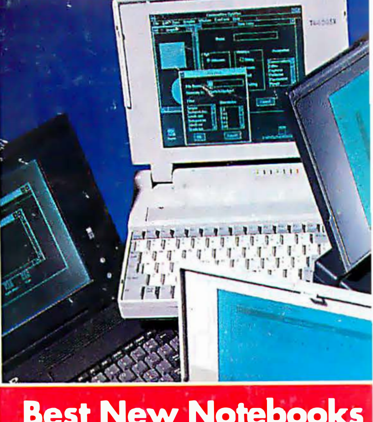
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BYTE

THE WORLDWIDE COMPUTING AUTHORITY

Is Unix Dead?

Unix is at a crossroads. Soon, Unix will face its most powerful adversary to date: Microsoft Windows NT. Will Unix survive?

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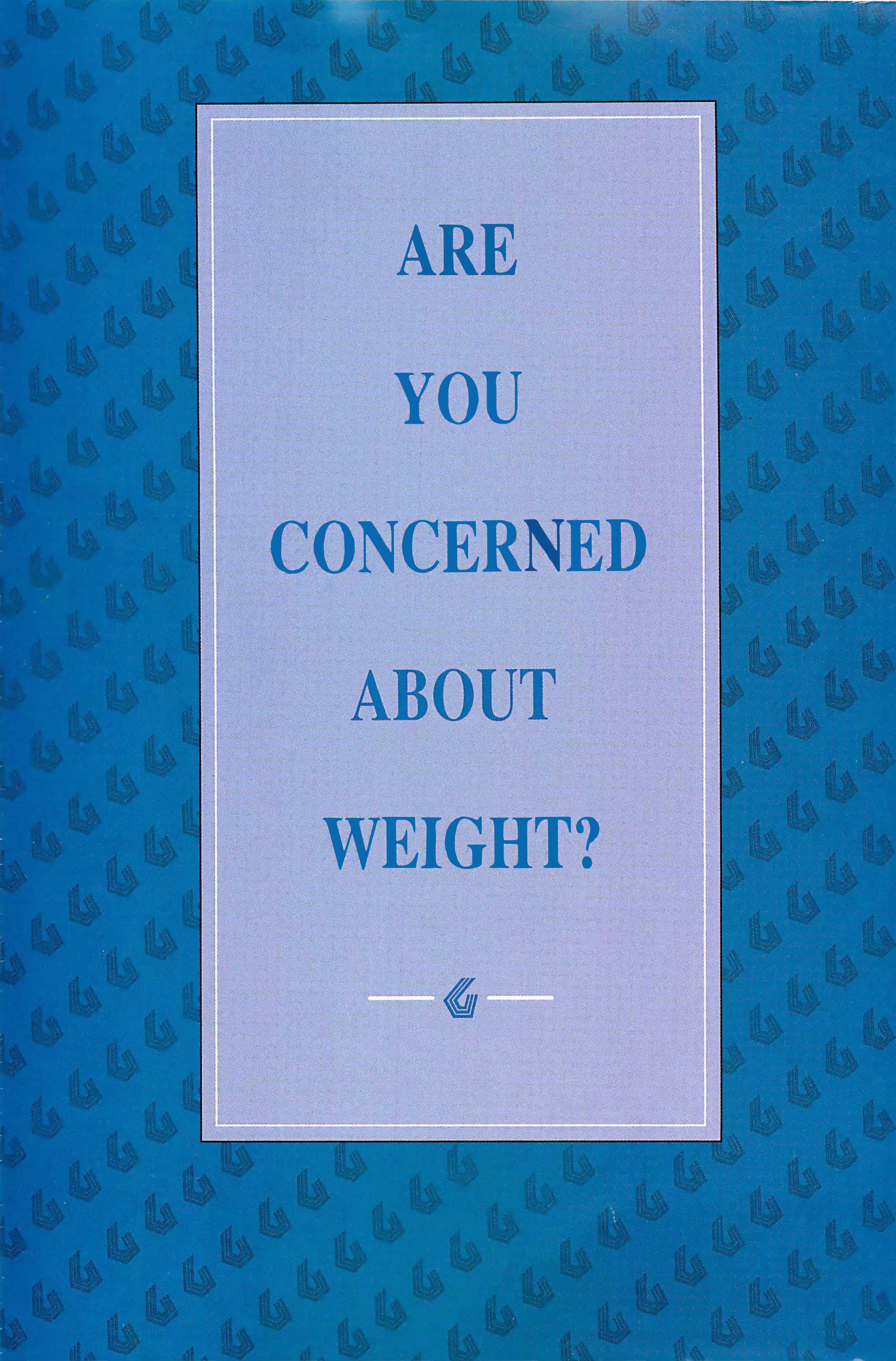
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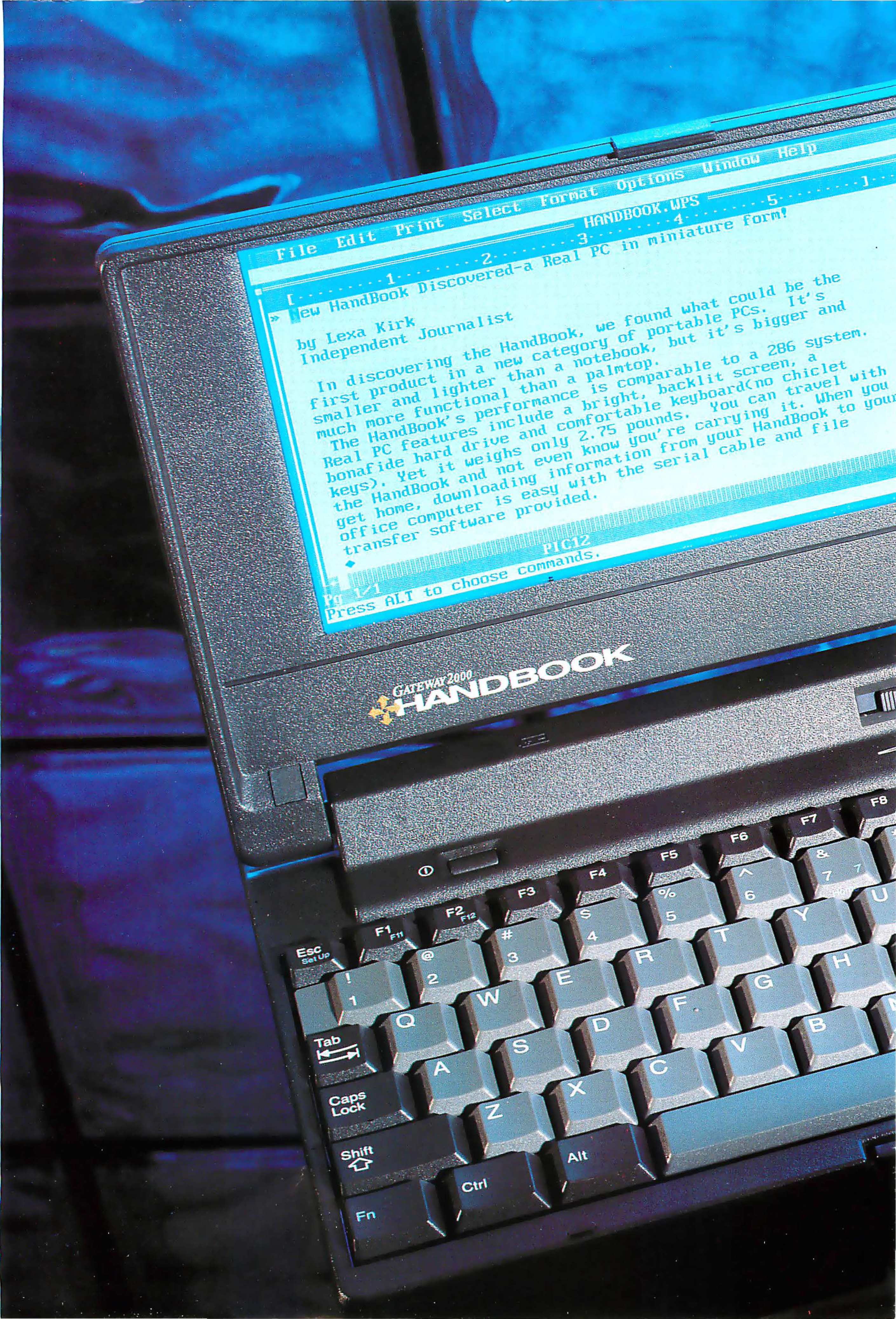
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ARE
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File Edit Print Select Format Options Window Help
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New HandBook Discovered-a Real PC in miniature form!
by Lexa Kirk
Independent Journalist
In discovering the HandBook, we found what could be the
first product in a new category of portable PCs. It's
smaller and lighter than a notebook, but it's bigger and
much more functional than a palmtop.
The HandBook's performance is comparable to a 286 system.
Real PC features include a bright, backlit screen, a
bonafide hard drive and comfortable keyboard(no chiclet
keys). Yet it weighs only 2.75 pounds. You can travel with
the HandBook and not even know you're carrying it. When you
get home, downloading information from your HandBook to your
office computer is easy with the serial cable and file
transfer software provided.
PIC12
Pg 1/1
Press ALT to choose commands.
GATEWAY 2000
HANDBOOK



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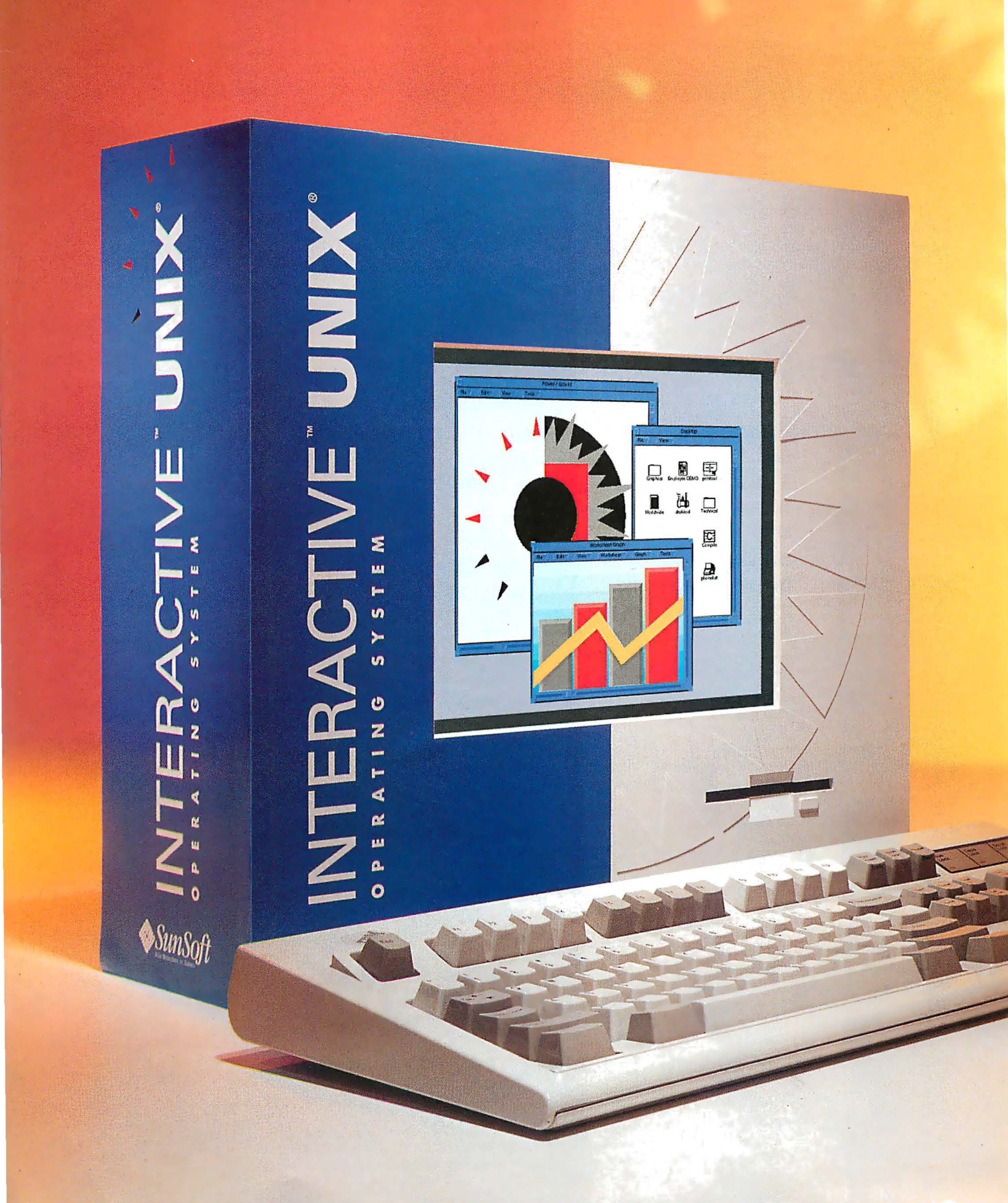
Options: FieldMouse™ pointing device, 2400 bps modem, alkaline battery pack, portable printer, combo unit (3.5" floppy drive with serial port and parallel port), extra batteries.

**Battery life was measured using PC Magazine's Battery Rundown Test with power management enabled. Results may vary.*



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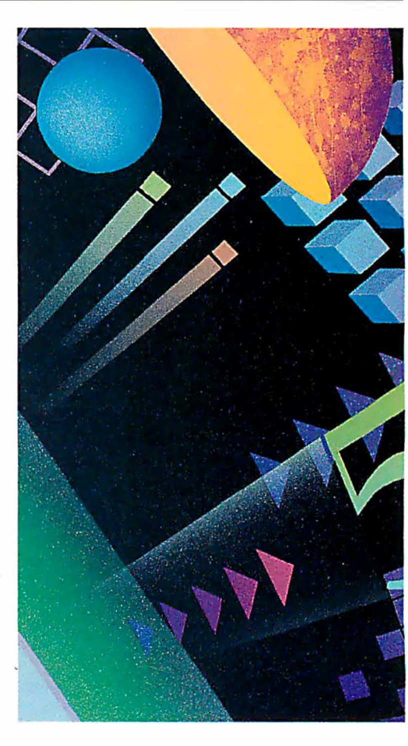
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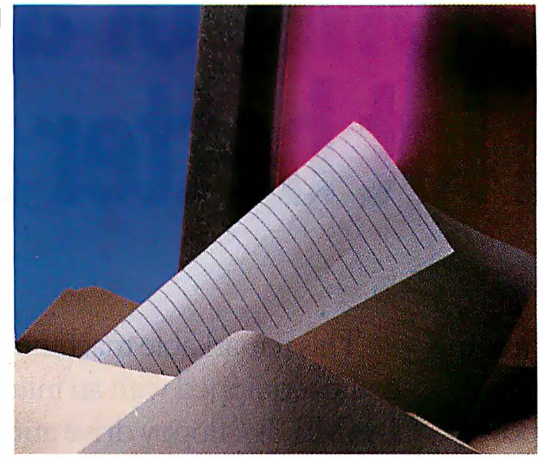
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One you wouldn't need a furniture dolly to move.

And here it is.

The Toshiba T6400.

With dimensions of 15.4" W x 10.5" D x 3.3" H (4.1" H with the color screen), it's small enough to fit in a briefcase.

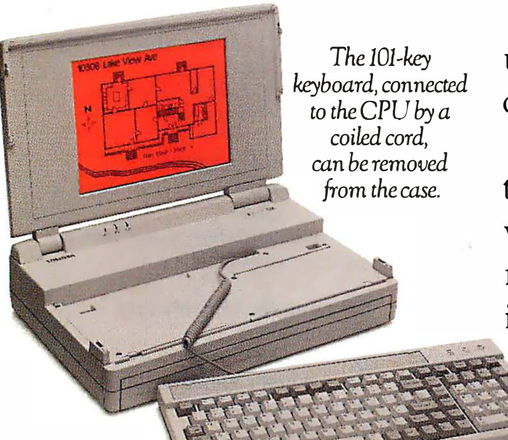
With a spirited clock speed of 33 MHz, a powerful 486 DX microprocessor, 8K internal cache and full 32-bit architecture, it's big enough to handle all those jobs normally performed in an impressive office building.

In addition to a 1.44MB floppy drive, you can choose a 120 or 200MB hard disk.



And if a combination like that doesn't make the T6400 portable better than the desktop computer you're currently using, we'll eat our collective hat.

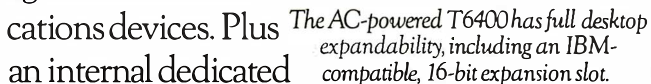
This remarkable machine comes equipped with an internal 1.44MB, 3½" floppy drive and a 120 or 200MB hard disk. Plus 4MB RAM, expandable to 20MB. (Try finding any application that needs more memory than that.)



The 101-key keyboard, connected to the CPU by a coiled cord, can be removed from the case.

There's also a full-length, IBM-compatible, 16-bit expansion slot so you can take full advantage of your network card, SCSI controller or any of a myriad of other special purpose cards.

For even more expandability the T6400 comes complete with a 150-pin expansion port for direct input/output to the CPU, enabling you to connect storage and communications devices. Plus an internal dedicated modem slot, as well as built-in parallel, serial, mouse and Super VGA video ports.



The AC-powered T6400 has full desktop expandability, including an IBM-compatible, 16-bit expansion slot.

Depending on your particular needs, you can choose one of two display screens.

A state-of-the-art active matrix Super VGA color display with Thin Film Transistor technology, to deliver a higher quality image than you can get with most desktop monitors, and capable of displaying 256 simultaneous colors at 640 x 480 resolution.

Or a gas plasma display featuring 16 gray scales, also at 640 x 480 resolution, and a 100:1 contrast ratio—seven times the contrast of standard LCD displays, with ten times the display speed.

Both have a diagonal measure of 10.4" and provide simultaneous viewing capability with external Super VGA displays.

To complete the T6400's amazing metamorphosis from desktop to portable, we took a 101-key keyboard



with full-size keys and key spacing, separate numeric keypad and eight dedicated cursor control keys, and nestled it into a compact 11.7 lb. package (12.9 lbs. with color screen). Then attached it to the CPU with a coiled cord, so you can remove it and use it on your lap (or other convenient surface).

Now, having read all of the above, you'd probably welcome more information on the T6400. If so, call us at 1-800-457-7777.

The more you learn about our products the more you'll come to understand the Toshiba philosophy: that portables are the future of personal computing.

Of course, with the introduction of the T6400 portable, it's a future that's already here.

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INSIDE BYTE

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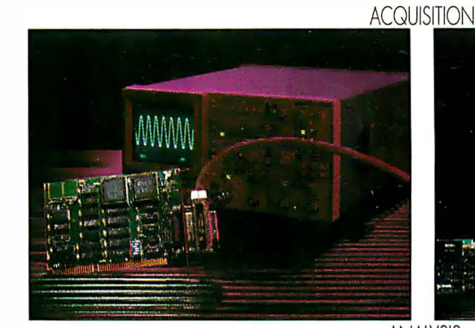
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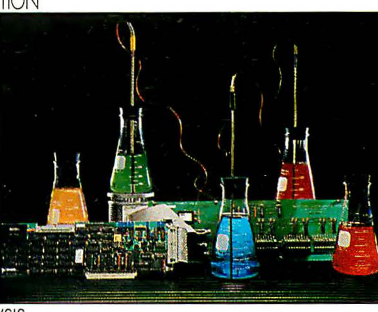
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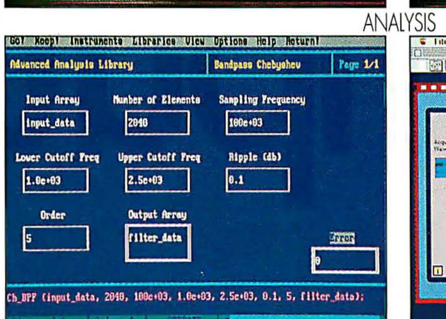
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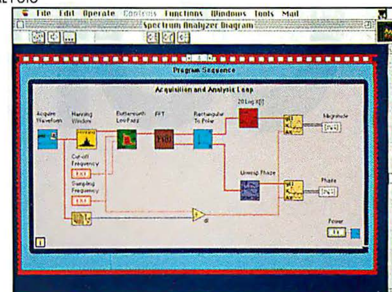
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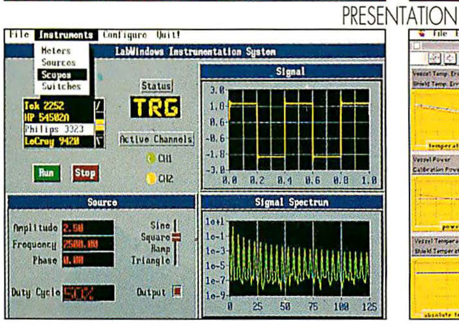


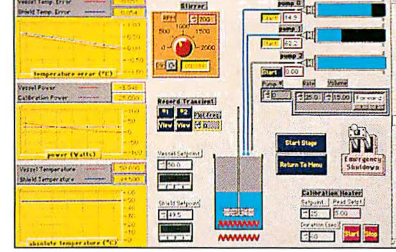
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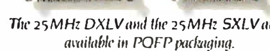
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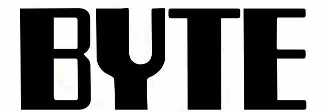
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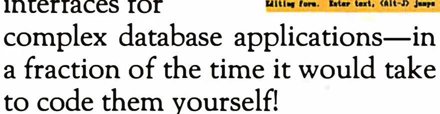
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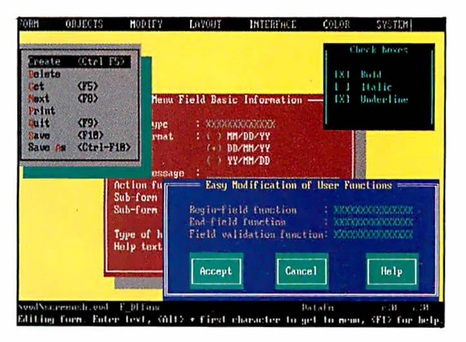
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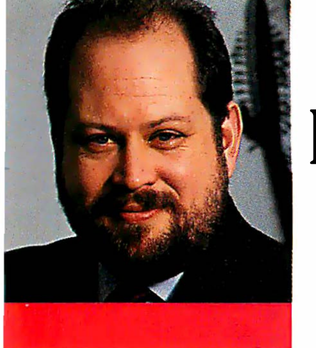


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IBM
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EDITORIAL

DENNIS ALLEN

THE GLOBALIZATION OF BYTE

Do you notice anything different about BYTE? On the cover, beneath the BYTE logo, look for our new tag line: "The worldwide computing authority." That statement is more than just a claim—it's a fact that is easily illustrated in this issue.

Notice the datelines in Microbytes and First Impressions. You'll find information on U.K.-based Acorn's new A4 notebook that uses the ARM (Advanced RISC machine) chip (page 72) and Italian computer maker Olivetti's new 2¼-pound subnotebook, called the Quaderno (page 70).

It's no longer possible to confine our news reports and articles to the U.S.

Read our feature article "The Greening of Computers" (page 147), and you'll learn how computer makers and users are taking ecology-minded steps in computing around the world. Read the lead article, "Photonics: Revolution or Evolution?" (page 168), in our State of the Art section, and you'll discover the newest developments in optical computing occurring in England, Germany, Japan, and the U.S.

Find out about fascinating computer industry happenings in the newly formed Commonwealth of Independent States by reading Rich Friedman's Report from Moscow (page 41). A recent trip there for a BYTE-sponsored computer show in Moscow gave Rich occasion to think about the programming talent in that country.

If you've been following the commodity price war of personal computers, you'll be interested in Alan Joch's Report from Taiwan (page 44). Alan and Rich Malloy visited the Computex show in Taipei to learn firsthand that Taiwanese clone manufacturers are trying to innovate products that bypass the commodity price war being fought by American manufacturers.

Why all this worldwide coverage? Simple. Computer technology, and therefore the computer industry, is not confined within the shorelines of North America. Nor does it stretch just to Japan. Exciting new developments are taking place worldwide.

Germany, for example, hosts the largest computer trade show in the world in Hannover. It's attended by more than half a million people. And that country is also the home of Siemens Nixdorf. Singapore, which has long been a major source for hard drive manufacturing, has a software development project that the country hopes will leapfrog the rest of the industry. Israel has both an active software development community and a community of hardware developers—many concentrating on LANs.

To be *the* authority on computing means being the *worldwide* authority, and that's what BYTE is doing. We know that it is not enough to focus just on what happens in the computer industry in North America while wearing blinders as to the rest of the world.

BYTE's unique standing in the global computer industry makes all this possible, and BYTE's unique publishing position is a tremendous strength. Not only is BYTE distributed in virtually every country in the world (our circulation outside the U.S. is larger than that of any other computer magazine), BYTE is also translated and reprinted in about a dozen languages. Our publishing partners and their local editorial offices are part of the BYTE network. They're located in Argentina, Australia, Brazil, France, Germany, Greece, Italy, Japan, Mexico, South Korea, Spain, Taiwan, and Turkey. Add to that BYTE's own editorial bureaus in London, New York, San Francisco, and Los Angeles, and you get an idea of BYTE's reach.

In my first editorial as Editor in Chief (February), I promised that BYTE would continue with its authoritative voice to separate truth from marketing hype and to put computing technology into a usable perspective. This globalization of BYTE is part of that commitment. BYTE's worldwide coverage provides you with a perspective that no other computer magazine offers, and it doesn't end there.

More to the point, look at our recent cover stories. In this issue, our writers and editors explore the answers to the question, "Is Unix Dead?" It's one of the most important computing stories of the year, and you won't find it anywhere else. The Unix-specific magazines cannot afford to raise the question, and the PC magazines don't cover the subject. Watch for more articles like this from BYTE in future issues. We think that it's exciting, and I hope you will, too.

—Dennis Allen
Editor in Chief
(BIX name "dallen")



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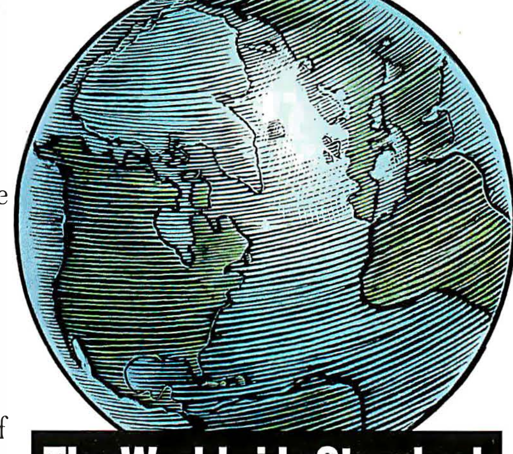
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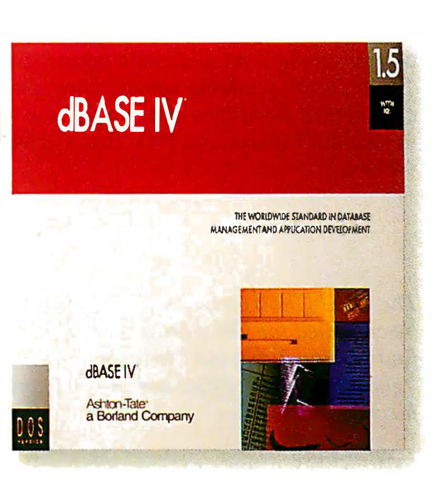
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LETTERS


BYTE REVIEWS

HARDWARE

Color at a Reasonable Price

TOM THOMPSON

Color PostScript Rebuttal

Readers can print color PostScript documents for a fraction of the $8000 that the printers reviewed in "Color at a Reasonable Price" cost by using inexpensive color printers, such as Hewlett-Packard's DeskJet or PaintJet, and Ghostscript software. This program does all the work in the PC instead of in the printer, so you can improve printing performance by simply upgrading the PC. Ghostscript supports the full set of PostScript extended color operators.

Ghostscript is freely available on the Internet for personal or in-company use, and it is distributed as part of the GNU software collection. Aladdin Enterprises will supply it on disk, with permission to copy, for $28.

The freely available version comes with no support. A commercial license, with support, is available by writing to Aladdin Enterprises, P.O. Box 60264, Palo Alto, CA 94306.

L. Peter Deutsch
President, Aladdin Enterprises
Palo Alto, CA

The GNU Ghostscript PostScript language interpreter can be compiled for Unix, DOS, and VMS machines. You'll find version 2.4 in the "listings" area on BIX as "ghost24.01." The files are in Unix compressed `tar` *format.*—Eds.

Tom Thompson's review of color PostScript printers ("Color at a Reasonable Price," June) begins by giving credit to QMS for introducing the first color PostScript printer and then neglects to mention any of QMS's four offerings. This is a disservice to readers who are considering color printer options, and it may give readers who aren't familiar with the QMS ColorScript line the impression that QMS is not an active player in this market.

During the article's planning phase, we were told that QMS ColorScript printers would not be among those reviewed because BYTE had reviewed one of our older models in years past and this article was to focus on newer models. Unfortunately, the article never explains what criteria were used to select the products reviewed. This gives readers the impression that you canvassed the market for *all* solutions that cost less than $8000.

QMS offers two such printers: the $6995 ColorScript 100 Model 10 and the $5995 Model 10p. Furthermore, several of the printers featured in your article were not much newer than the latest QMS offerings.

Terry Harbin
Director, Marketing Communications
QMS, Inc.
Mobile, AL

We excluded the ColorScript 100 Model 10 because we reviewed it in the December 1989 issue (see "What Price Color PostScript?"). We inadvertently omitted the reference to this review in our June roundup of color PostScript printers. We contacted QMS about the Model 10p, but this unit was not available in time for inclusion in the June roundup.—Eds.

As lead development engineer at Seiko, I have some concerns after reading "Color at a Reasonable Price."

You neglected to mention that the Personal ColorPoint can print on postcards and B4-size paper.

The Personal ColorPoint, which comes with a parallel port only, has a list price of $3995; the ColorPoint PS, which has an AppleTalk port, lists for $4995. The review did not make this distinction clear; it sounded as if the customer would have to buy an extra board for our printer.

The CalComp ColorMaster Plus, Tektronix Phaser II PXi, and Seiko Personal ColorPoint all offer enhanced screening that improves halftoning. Yet the only printer you mention as having this feature is the Phaser II PXi.

Mark Bate
Seiko Instruments U.S.A., Inc.
San Jose, CA

The Scoop on Zinc

I'd like to clarify a few points made in "Zinc-Air Batteries: Long May You Run" (Microbytes, May, page 28). We designed our stand-alone 12-volt battery system to operate portable computers—not cars—for 10 to 30 hours. The battery will power a computer and a printer together for more than 16 hours.

The prototype battery demonstrated at Technologic Partners Pen Computing '92 weighs 2½ pounds. The battery pack weighs 1½ pounds, but that includes a 1-pound air manager. When the battery system is designed into a computer, the computer manufacturer incorporates the battery's air manager into the computer's housing. With proper design, the air manager will add no more than 1 or 2 ounces to the computer's weight.

Also, the prototype shown at the conference did not optimize the battery's footprint. We can fit a 5-V battery into an 8½- by 11-inch package.

Frank M. Harris
Vice President, Marketing and Sales
AER Energy Resources, Inc.
Atlanta, GA

Digital Deceptions

I enjoyed reading Steve Moore's "Digital Deceptions" (Stop Bit, May). While I agree with his statements on the possible misuses of digital manipulation, he far underestimates its potent effect. Had digital video manipulation been a bit more advanced at the time, we might have seen Saddam Hussein telling his troops to pull out of Kuwait

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long before multinational forces pushed them out. The technology for jamming and transmitting TV signals is here now, and believable digital impersonation will be here soon. The military applications of this technology will, without a doubt, have a profound effect on the way wars are fought in the future.

Don Barton
Grand Junction, CO

Electronic Books and IBM

I was in a state of shock after reading "Electronic Books" (June). I know that there are many people in the U.S. who automatically tune you out when you mention IBM, but when a company leads the industry in a particular area, it should at least get some sort of acknowledgment.

IBM has had a cross-platform product for reading and building on-line books for over five years. BookManager is available for VBS, VM, PC-DOS, and OS/2. It provides full hypertext linking and bookmarking, lets you add personal notes, and offers other features. It also lets you use the same source files for both hard-copy and on-line books.

BYTE shows a negative bias toward IBM by ignoring the availability of several thousand IBM manuals that are usable in both hard-copy and on-line form.

Roger A. Root
Raleigh, NC

Infoglut Solved!

Regarding Dennis Allen's editorial titled "Managing Infoglut" (June): The best-kept secret in the world can now be revealed. The best manager of information, whatever the format, is not a software product at all. It's a librarian! Hire one today.

Frank White
Automation Librarian
University of Windsor
Windsor, Ontario, Canada

Internet Kudos

Thank you for providing an Internet address for sending letters to the editor. I hope that this community inundates you with Internet mail so that the connection proves worthwhile.

Rich Oesterling
Idaho Falls, ID

Image Correction

In his review of WinRix 1.1 ("Image Magic," Windows Special Report, June), Dana Hudes erroneously reports that the package lacks several features.

WinRix supports calibration for scanner, screen, and printer. You accomplish this by creating a custom lookup file and applying it to the scanner, edit window, or printer. This allows you to not only calibrate the device but also calibrate for known differences in source or output attributes. For example, photos taken under fluorescent lighting have a more greenish tone than other photos. With the methodology that we at Rix Softworks have implemented, you can create a lookup file for these photos. In our opinion, you don't always want WYSIWYG.

Our scanner interface supports the changing of the scan resolution if the feature is available on the scanner that is being used. WinRix supports several scanners that were not listed in Hudes's review, including those from Logitech, Marstek, Genius, Ricoh, and OBM. It supports object and raster (i.e., bit-mapped) fonts and displays a visual sample of the selected text in the dialog box to assist user selection. WinRix custom lookups support individual RGB-channel or global adjustments and gamma-curve manipulation.

The package also fully supports rubber-band area-selection tools. You can stretch and relocate all selected areas before committing to the selection you've made. We intentionally reduced the number of icons to eliminate redundant screen clutter. The square and circle entries are only forms of the more general rectangle and ellipse.

We appreciate Hudes's testimonial to our display quality, but the choice of screen dithers is just that—a choice. You can choose ordered (Windows standard), diffused, or halftone dithering from the View Preferences Display menu.

As with our competition, you can use the WinRix 1.1 magic wand and other area-selection tools for bucket fills. The ScanRix scanning application for DOS does not ship with WinRix; SnapRix, our screen-capture application, does. WinRix costs $395.

In light of the aforementioned comparison deficiencies, we believe WinRix to be the best buy.

Joseph R. Fisher
Vice President, Marketing/Sales
Rix Softworks, Inc.
Burlington, NC



- The correct toll-free number for Hercules Computer Technology, Inc. ("Flying Windows," June), is (800) 532-0600.
- The maximum storage configuration for the Sparcbook ("SPARCs on the Road," May) is not 125 MB. The Sparcbook can accommodate up to 240 MB of data on two internal hard drives.
- The sentence in "Displays: The Human Factor" (July) on page 196, column 3, paragraph 2 under the subhead "Luminance Perception" that says "Roufs's work is now a..." should read "Nonlinearity is now a...." On page 197, column 1, paragraph 4 under the subhead "Fixing Flicker," the sentence that states "display cost closely follows the field rate" should read "display cost closely follows the frame rate." In addition, Bernice E. Rogowitz's title is Research Staff Member at the IBM T. J. Watson Research Center.
- Prentice-Hall is the publisher of *The Decline and Fall of the American Programmer* (Book and CD-ROM Reviews, July). ■

I FEEL LIKE I'M BEING PECKED TO DEATH BY DUCKS.

At $149.95 per PC, Windows sounded like a deal. Then I bought all new programs at about $500 a pop. I shelled out a couple hundred per machine for extra memory. I ponied up $300 each for networking cards. The mouse ran $100 and a bigger hard disk ran $275. And as I stare at the invoice for what it's going to cost me to connect them all together, I think to myself,

"THIS IS MAKING IT EASIER?"

Then there's Macintosh.® There are no hidden costs. There are no cards to buy for networking, file sharing, sound, video or peripheral support. That's why *Computer Shopper* magazine said, "Let's not be coy: If you want the best GUI money can buy, get a Macintosh." That's why *MacWeek* said, "Apple has shown that it can be technologically brilliant and price competitive at the same time." And that's why J.D. Power and Associates ranked Apple the #1 Personal Computer Company in Customer Satisfaction Among Business Users.* There's no personal computer on earth quite like it. And none more imitated. The affordable, compatible, connectable Macintosh personal computer. The power to be your best.®

Macintosh from Apple.

J.D. Power and Associates 1991 Computer End User Satisfaction Study℠: Phase IV: Business End User Summary. Responses from 5,811 end users at 4,396 business sites. Computer Shopper quote reprinted from April 1, 1992 issue. ©1992 Coastal Associates Publishing, L.P. MacWeek quote reprinted from October 22, 1991, issue.



Kaleida Hopes that X Marks the (Multimedia) Spot

When IBM and Apple announced their joint-venture software company Kaleida, officials said that the new company would license existing technology from the parent companies and create uniform specifications and file formats for multimedia data. Kaleida would then license these multimedia technologies back to IBM and Apple and other third parties.

IBM and Apple revealed little else about what Kaleida was developing, leaving observers to speculate about who would direct the company and the mysterious projects it was involved in that had names like Sweet Pea and Script X. In just one week in late June, however, all that changed.

First, Apple and IBM said that Kaleida's president and CEO will be Nat Goldhaber, venture capitalist and founder of the company that developed the TOPS distributed file-server LAN for incompatible computers. Once named Kaleida's CEO, Goldhaber revealed that Apple and other companies, such as Japanese consumer-electronics giants Sony and Toshiba, will use Kaleida technology in their PDA (Personal Digital Assistant) systems.

Goldhaber told BYTE that two technologies currently under development at Kaleida for hand-held personal multimedia/communications devices are Script X, a universal multimedia scripting language, and COS (consumer operating system), a real-time kernel designed for small portable devices. "We won't manufacture the devices but will play a major role [in their development], either through design or through creating the tools to do the design work," he said. Goldhaber said that the information units "require not only communication links and devices but also a big body of beautifully and intelligently wrought information software."

Goldhaber said Script X will provide the basis for the formation of these intelligent programs. It will execute on devices ranging from Sweet Pea, the CD-ROM-based PDA currently being developed, to the Mac and other future systems, including the PowerPC.

"Script X will be linked intimately to the TV set," Goldhaber said. "Script X is designed to be that language that, for the most part, an author of a title [i.e., an intelligent infotainment program] can produce that title just once for multiple platforms." Plans call for Script X to run on Macs, Windows, OS/2, and Unix platforms. "QuickTime will also be part of the Script X environment," Goldhaber said, adding that Script X–compliant PDAs will play QuickTime movies. He also said that Script X will execute natively on COS. Although he didn't discuss specific release dates, Goldhaber said that COS and Script X are fairly well along.

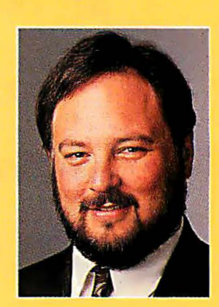
In discussing Kaleida and what he hoped it would provide for all people, Goldhaber referred to several speeches he delivered in the 1980s, including one he made in October 1989 to the Boston Computer Society. In that speech, Goldhaber spoke of a truly intuitive multimedia device that merged TV and the PC with an HDTV-quality display. Users would—through an interface that Goldhaber said would need to be far more intuitive than anything currently offered on PCs, Macs, or VCRs—be able to indicate the topics of interest to them and have those topics delivered to the system automatically. At Kaleida, Goldhaber has an opportunity to turn his vision into reality.

Goldhaber told BYTE that Kaleida will participate in projects that IBM is working individually with Time Warner and Bell Atlantic to provide video on-demand services. He added that Kaleida may also participate in a similar project with Hewlett-Packard.

—David Andrews

NANOBYTES

In discussing the technologies that Kaleida is now working on, newly appointed Kaleida CEO **Nat Goldhaber** said that one of the key considerations is to create products that present information in an entertaining way: "The problem with the computer metaphor is it's very intimidating for many people. It lacks that warm and fuzzy quality that makes it interesting to explore." He said that if a device is to succeed in providing information to all people, not just computer users, it must be accessible. □



Unconfirmed reports say **Apple** is asking companies, including Japanese consumer-electronics companies **Matsushita, Toshiba, and Sony**, to contribute millions of dollars to support its Bento multimedia specification. In return, the companies who support Bento will also get early access to technologies developed at Kaleida. Bento is a cross-platform standard for documents containing multiple data types. □

Toshiba Corp. of Japan is working with Apple to develop a CD-ROM-based multimedia player called **Sweet Pea**. Details on the system are scarce, but a Toshiba spokesperson told BYTE that the player will span the entertainment, information-on-demand, and lifelong-learning markets. It is expected to ship in mid-1993. Toshiba said it is also negotiating with Time Warner to provide consumers with a "wide spectrum" of multimedia titles for consumers. □

IBM Gets the Ambra Light

LONDON—In a roughly $15.2 million (£8 million) blaze of publicity more suited to a soft drink sales campaign, IBM has burst onto the European low-cost clone scene. Its new product range, comprising two desktops and a notebook, has been christened Ambra, with the first TV advertisement featuring images of taut young bodies exercising in a gymnasium. The machines, which have racy names like Sprinta, Hurdla, and Treka, come in various configurations at prices ranging from about $1600 (£885) to $2700 (£1449). The desktop PCs are powered by AMD's 25-MHz 386SX and the notebooks by a 20- or 25-MHz Intel 386SL. A 486 model is expected later this year. The machines are based around the ISA bus rather than IBM's Micro Channel architecture bus.

IBM's new wholly owned subsidiary company, called Individual Computer Products International, will source and sell the machines. It expects to sell up to a third of its machines directly, with the remainder being sold through the reseller channel and retailers such as the Wildings U.K. office equipment store. The PCs will also be shipped directly from the Far East to an IBM subsidiary in Canada.

ICPI's direct selling prices exclude VAT (value-added tax). They do, however, include preinstalled DOS and Windows, a one-year on-site warranty, and use of a technical-support hotline. Resellers can set their own prices as low as they like, but the IBM connection and the advertising may help retailers avoid a price war.

—David Tebbutt

VeriFone Banks on Synaptics' Neural-Network Chip

VeriFone has released the Gemstone Onyx check reader, a device for the PC that uses a neural-network chip designed by Synaptics to intelligently recognize and process numeric information that appears on bank checks. According to Ashok Narasihman, vice president and general manager of VeriFone, the new device, which processes image information in a manner similar to the way in which the human eye does, offers retailers a more efficient and faster method of processing checks than traditional motorized check readers. VeriFone and Synaptics say that the device is the first commercial application of neural-network technology, which mimics the way a human brain processes information.

At the heart of the Gemstone Onyx check reader is the Synaptics I-1000 neural-network chip. The I-1000 chip integrates an imager (with image preprocessing), an analog neural-network classifier, and digital electronics. A silicon eye in the device reads images through a lens at a resolution of 18 by 64 pixels; the image is then sent to the I-1000 chip, which determines what the object is. The Onyx check reader has achieved a 99.6 percent accuracy rate in recently completed independent lab tests conducted by SRI International.

—Patrick Waurzyniak

Department of Justice Official: Managers Need More Proactive Security

WASHINGTON, D.C.—Information systems managers need to be more proactive in detecting computer crimes, according to a U.S. Department of Justice official. Speaking to about 250 attendees at LAN/SEC 92, Scott Charney, chief of the Justice Department's Computer Crime Unit, noted that the appearance of inexpensive modems has helped spawn a criminal industry. Unfortunately, security devices and security practices are costly, and management is reluctant to pay for them when a problem is not immediately evident, Charney said.

Charney said that hackers' attempts to obtain passwords by running the entire dictionary past the password request work about 20 percent of the time. A more devious technique is to substitute a program that looks and acts identical to an actual sign-on screen.

"Don't wait until you're hit; use non-dictionary passwords, educate users," Charney advised. If you are the victim of computer crime, "keep audit trails, keep the records in a safe place—not where intruders can find (and alter) them," he said.

—Stephen Banker

NANOBYTES

IBM's **Pennant Systems** (Norwalk, CT) and **Hitachi** (Tokyo) and its affiliate company **Hitachi Koki** have agreed to work together in developing what an IBM spokesperson said will be "the next generation of printers." Hitachi Koki will manufacture high-, medium-, and low-speed print engines for continuous and cut-form printers. Either Pennant Systems or Hitachi Koki will produce the controllers, and software will be developed by Pennant Systems. IBM will market the final products worldwide. □

Northgate Computer (Minneapolis, MN) and **Everex Systems** (Fremont, CA) have discontinued discussions regarding a possible merger. Soon after rumors surfaced that IBM might buy Northgate, Everex signed a letter of intent to buy it. Northgate now says that an investment group will purchase 51 percent of Northgate's common stock and provide at least $3 million in financing. □

Symantec (Cupertino, CA) has acquired **MultiScope** (Mountain View, CA), developer of MultiScope Debuggers for Windows, DOS, and OS/2, and **The Whitewater Group** (Evanston, IL), developer of the Whitewater Resource Toolkit and Actor, the OOP (object-oriented programming) language package for Windows application programming. Symantec's move brings it two steps closer to its master plan of being a multiplatform development tool provider, explained Neal Goldman, product manager of PC language products at Symantec. Both of the acquired companies will retain their corporate identity. □

Starting this fall, Compaq's new **Peripherals Division** will release a series of network printers. The division will be headed by David Black, who previously directed the development of Compaq desktop and portable PCs. □

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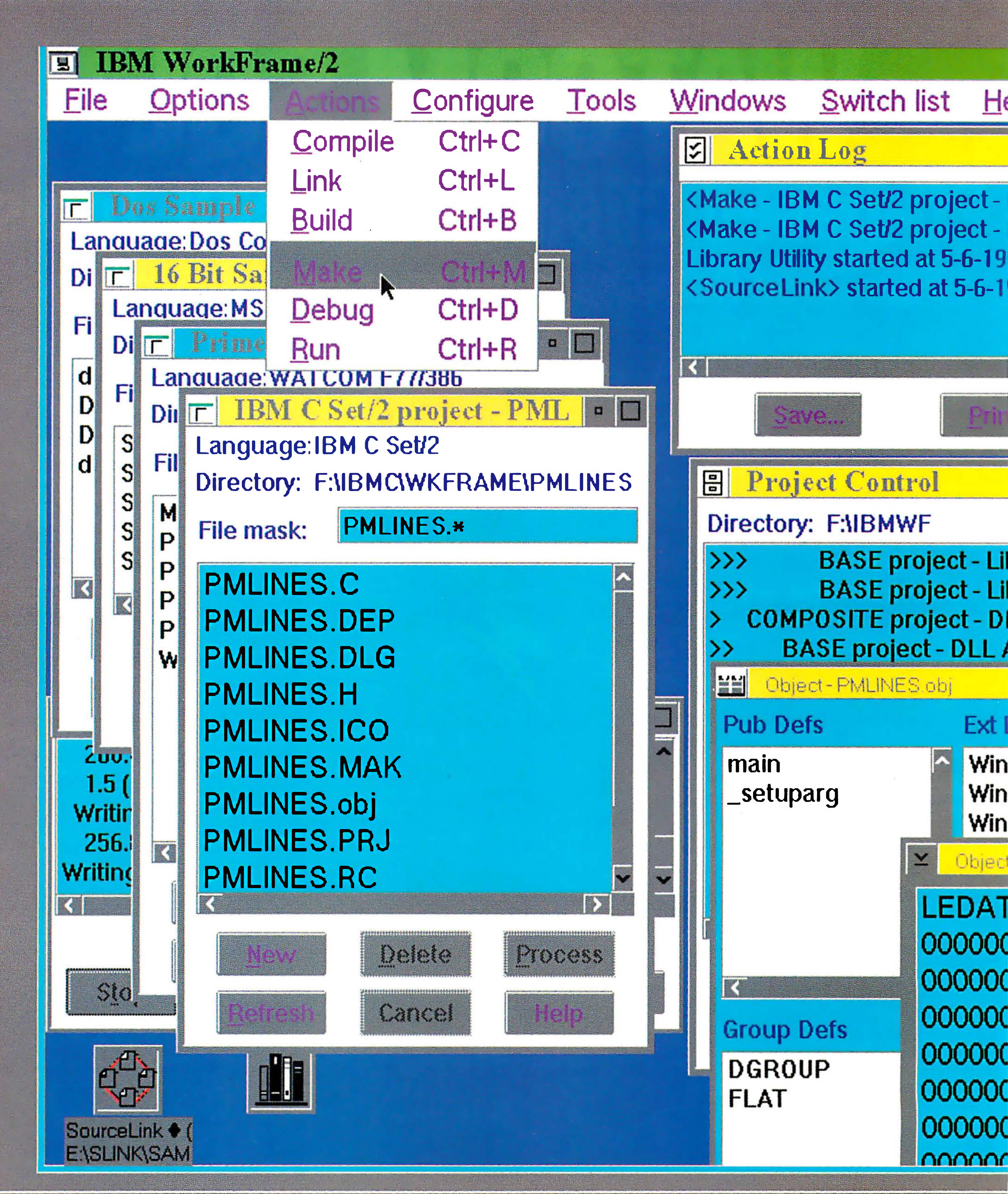
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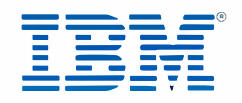
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WordPerfect Wises Up

WordPerfect (Orem, UT) is trying to position its market-leading word processor at the center of a universe that includes the supporting role of E-mail, group scheduler, and calendar through WordPerfect Office, and, in the future, new products such as forms creators and document managers. The new strategy, recently unveiled as WISE (WordPerfect Information System Environment), comprises three basic activities: information processing, information sharing, and information presentation. The company's development plans center around delivering applications within these three categories on six platforms. Complete interoperability—both of data and procedures—among DOS, Windows, OS/2, Macs, Unix, and VMS is a major engineering goal.

At the heart of the information-processing segment is the WordPerfect word processor. The company now sees the program as a vehicle for delivering information to the desktop. To position WordPerfect documents as the center of the office, the company will improve links between documents and other data. Better ties to spreadsheets and databases are in the works, and the company is developing an open API that will permit other programs to use WordPerfect support facilities (e.g., a third-party database could call the WordPerfect spelling checker). These changes will likely mean the end of DataPerfect and PlanPerfect, the company's database and spreadsheet products.

To promote information sharing, WordPerfect will reposition WordPerfect Office as an E-mail and multiuser scheduling facility. The company will also add support for methods of mail transport such as the emerging OCE (Open Computing Environment), VIM (Vendor-Independent Messaging), and MAPI (Messaging Application Programming Interface), and even the Open Software Foundation's DCE (Distributed Computing Environment) protocols. As part of its information-sharing thrust, WordPerfect plans to deliver document management and forms design and fill packages this year.

The final activity of WISE, information presentation, has support for printing, document viewing, and multimedia. Like viewers from Frame Technology, Interleaf, and Adobe, the document viewer will let you read WordPerfect and documents on systems that lack these creating applications.

The success of this new strategy may depend on how quickly WordPerfect can develop all these new products for six different environments. To speed up the process, WordPerfect is moving away from assembly language toward a portable C- and C++-based core-code design.

—Andy Redfern and Andy Reinhardt

Starlight Networks Adds Jostens as Investor in Network Multimedia

Starlight Networks (Mountain View, CA), a company that plans to announce this fall a network server and software that promise the transmission of stored video over a network without image degradation, has added Jostens Learning as an investor. Jostens Learning (San Diego, CA), a developer of instructional technology programs, has also signed a multiyear, multimillion-dollar contract with Starlight to use its technology in its recently announced Jostens Learning InterActive-Media curriculum products, Starlight says.

The transmission of stored video from a server to a client presents a problem for packet-based LANs. Unlike other types of data, video must be able to flow without interruptions, which degrade its quality. A Starlight Networks spokesperson said the company is developing a technology that lets workgroups have simultaneous access to full-motion video over current LANs and WANs (wide-area networks). Video applications will be able to coexist with desktop computer applications on the same network. Starlight Networks plans on supporting multiple types of LANs, including Ethernet, Token Ring, and FDDI (Fiber Distributed Data Interface).

Jostens Learning plans to use Starlight's products in what it is calling its next generation of instructional curricula, which is based on networked multimedia. A Jostens representative said that the curriculum relies on interactive full-motion video to grab and hold a student's attention.

Founded in 1990, Starlight Networks' investors include Bass Associates; Accel Partners; InterWest Partners; Merrill, Pickard, Anderson & Eyre; and Nynex Venture Company.

—David Andrews

NANOBYTES

To achieve better market leverage, **WordPerfect** is undertaking an aggressive program of partnering with other companies. WordPerfect has entered a cooperative product development and support program with Novell, the major element of which will be the creation of WordPerfect Office as an NLM (NetWare loadable module). Other announcements include the licensing of Adobe Type Manager's rendering technology and support for the TWAIN image and document manipulation specification already adhered to by Aldus, Caere, Kodak, Hewlett-Packard, and Logitech. □

In another break with the past, WordPerfect announced its first acquisition, Illinois-based **MagicSoft**, which makes the communications software used in WordPerfect Office. WordPerfect making acquisitions? This may be only the beginning. □

Olivetti (Milan, Italy) and **Novell** have signed a master business agreement that will expand the already-close relationship between the two companies. Included in the agreement are plans for full support of Novell NetWare under the Olivetti OSA (Open Systems Architecture), joint marketing events, and a new rigorous training program for technical employees. The first step toward NetWare integration calls for native NetWare support in OSA. □

A start-up company in Boston is developing a spreadsheet for Next workstations that reads and writes Lotus WKS and WK1 files and executes Lotus 1-2-3 release 2.3 macros. **Athena Design** ((617) 734-6372) says its Mesa spreadsheet is the only traditional spreadsheet written exclusively for the NextStep environment. David Pollak, president of Athena Design, says Mesa has received considerable interest from Wall Street financial houses that now use Next computers. □

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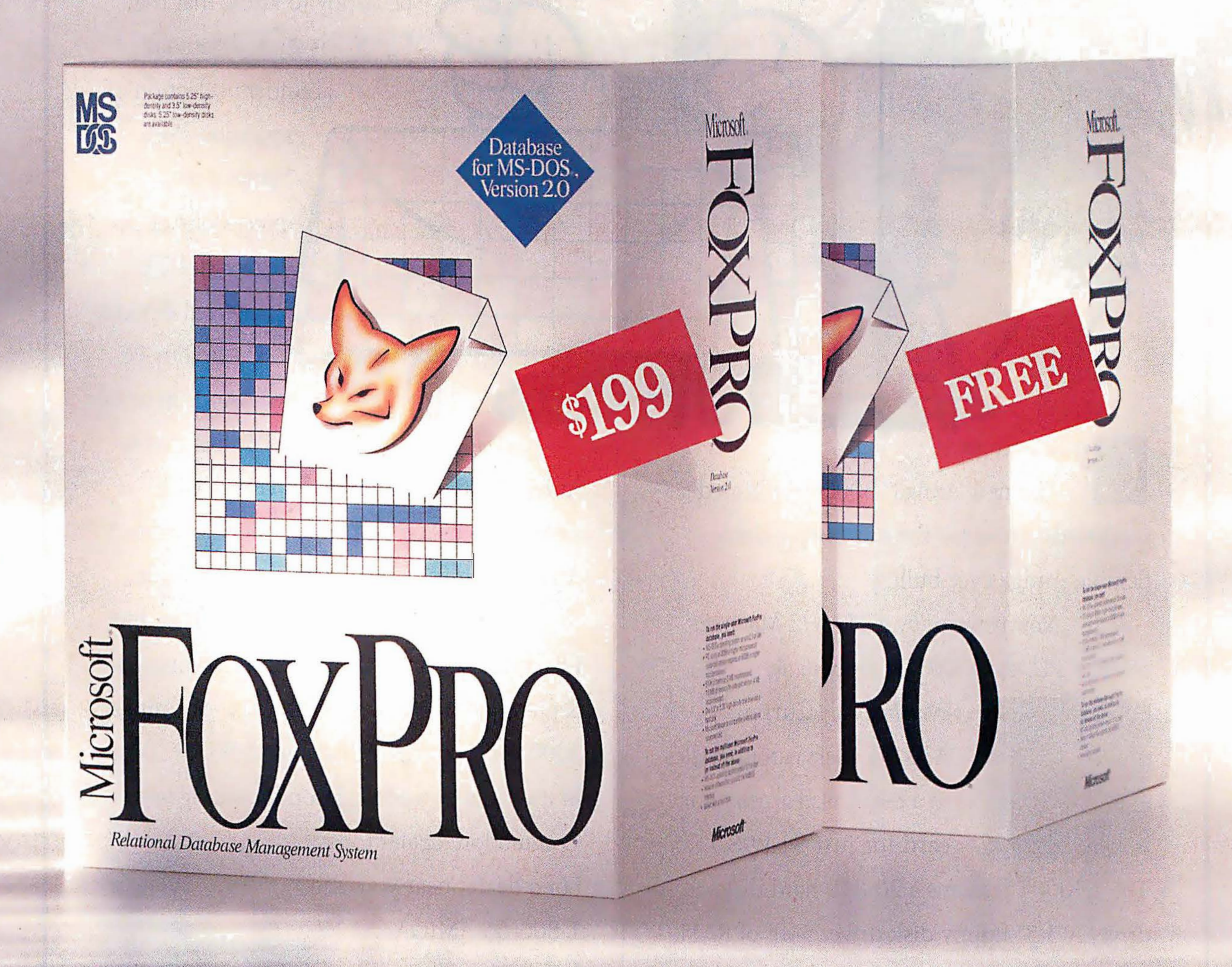
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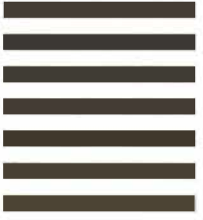
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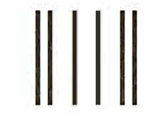
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SPARC Vendors Enhance Chip Specification

BURLINGAME, Calif.—SPARC International has come out with a new chip specification offering several performance improvements, including a 64-bit address space that the nonprofit consortium claims will carry the SPARC architecture well into the next century.

Besides the SPARC architecture version 9, which extends SPARC's address space to 64 bits, the specification also includes an enhanced instruction set specifically designed for superscalar implementations, as well as improved support for the Unix operating system and better multiprocessing support.

"What we're doing is what's called 'roadmapping,'" said Sun Microsystems' chairperson and CEO Scott McNealy. "Seriously, you have to [look at the SPARC world's future] because people think you are dead if you don't," he commented. In response to the promise by DEC that its competing Alpha architecture will carry its customers through the next 25 years, McNealy said, "In keeping with that, version 9 will take you into the year 3000—beat that, Alpha!"

The SPARC version 9 specification offers full 64-bit extensions to the previous SPARC version 8, on which two recently introduced superscalar implementations, Texas Instruments' SuperSparc and Cypress Semiconductor's HyperSparc processors, are based. The version 9 specification extends all the version 8 integer registers to 64 bits, and all register commands work on the full 64-bit register with full hardware support for 64-bit arithmetic, including multiplication and division, according to SPARC International.

Several new instructions have been added to increase the performance of both superscalar and superpipelined machines. David R. Ditzel, who is chairperson of the SPARC architecture committee and the director of advanced systems at Sun Microsystems Laboratories, said the new specification adds about two dozen instructions to those of the previous SPARC version 8, bringing the total instruction set to slightly over 100.

The new SPARC specification provides fault-tolerance capabilities through a compare and swap instruction. The specification also includes a new fast-trap model and context switching for increased performance.

SPARC International emphasizes applications written for previous SPARC machines are compatible with the new specification.

—Patrick Waurzyniak

Symantec and Apple Announce Cross-Platform Development Tool

NEW YORK—Symantec (Cupertino, CA) and Apple announced at PC Expo that they have entered into a development and marketing agreement that will provide an application framework for developers that will allow the same code to run on both Macs and Windows-based PCs. Based on the "Bedrock" technology that Symantec has used internally for two years, both companies hope that the framework, which uses C++ and object-oriented approaches, will be extended in the future to support OS/2, Unix, Windows NT, and other operating systems.

An application framework provides a common set of building blocks, or *objects*, that provide the basic structure for an application. MacApp, Apple's framework, already provides an object structure for Mac developers. Apple and Symantec envision a framework that acts as a buffer between a program and the target platform of the processor and native operating system. Symantec is providing the Bedrock framework, which will be combined with elements of Apple's MacApp. Apple and Symantec officials said the two companies will use the Bedrock framework technology internally and work together to support the developers' transition to Bedrock. Symantec will own the technology.

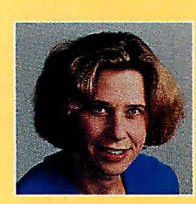
Bedrock maps abstract objects such as Documents, Panes, and Menus into platform-specific functionality instead of just Mac-specific functionality. The three major elements of Bedrock include the Bedrock Class Library (i.e., components for building an application in C++), Bedrock Resource Information (e.g., view positioning, dialog boxes, and screens), and the Bedrock Utility Manager (i.e., machine-specific services).

Slated to be finished in the first half of 1993, the product will be available through both Apple and Symantec distribution channels. Apple said that it will provide an upgrade path for current MacApp users.

—Larry Loeb

NANOBYTES

Palm Computing (Los Altos, CA), developer of software for consumer palmtop pen computers, has named **Donna Dubinsky**, former international vice president and cofounder of Claris, as its new president and CEO. "The technologies in miniaturization and handwriting recognition are getting us to the point where we can get a powerful open system in the palm of your hand," she said. But she added that companies are still researching what the market wants these applications to be, whether it's a pager, software player, Rolodex, or something else. "It's going to be a bit murky here for a while, and anytime you're developing an open system, it's going to be a battle of the platforms," Dubinsky said. □



Windows has been criticized for not being accessible to the visually impaired. However, thanks to Window Bridge from **Syntha-Voice Computers** (Hamilton, Ontario, Canada, (416) 578-0565), a new program that supports commercially available voice synthesizers, Windows applications can now be accessed via voice output by blind computer users. □

KnowledgePoint (Petaluma, CA, (707) 762-0333), a vendor of programs that enable you to write personnel policies and employee handbooks, has released **DescriptionsWrite Now**, a PC-based program that custom-writes complete job descriptions. KnowledgePoint says that the program helps companies comply with the new ADA (Americans with Disabilities Act): Written job descriptions are an important piece of evidence in both justifying and defending employment decisions, says Michael Troy, KnowledgePoint's president. □

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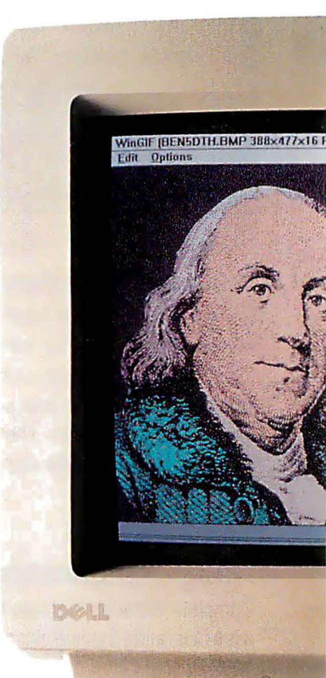
i486™SX 25 MHz System
4 MB RAM, 120 MB Hard Drive, Dual Floppy Drives (3.5" and 5.25"), Ultra VGA 1024NI Monitor (14", 1024 x 768, .28mm), MS-DOS® 5.0/Microsoft® Windows™ 3.1/Mouse

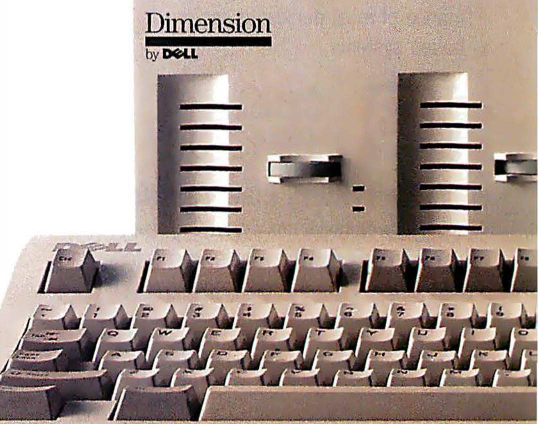
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PC Price Wars: Bad Omen for R&D?

Call it a period of retrenchment for PC makers: IBM has forged alliances with former enemies like Hitachi and Apple. Compaq has abandoned the ACE (Advanced Computing Environment) initiative to better shore up its Intel-platform products. Companies such as Zenith Data, CompuAdd, and NCR have announced price cuts across product lines. Dell, too, has increased its cost-cutting campaign to better compete in the current PC price war: Even its top executives have taken a pay cut.

Does the current price war translate into less money for research? No company will own up to cutting R&D funds, but when times are tough, R&D funds often become expendable. At the very least, the current price war is causing companies to refocus R&D toward whatever will most quickly distinguish the company and spoon in more market share. "A prescription for going out of business is cutting your R&D spending," said Andrew J. Neff, managing director of the New York investment research firm Bear, Stearns & Co. "The companies that do will be the ones to go in the shakeout."

Looking at the top microcomputer makers, such as IBM, Compaq, and Apple, it's difficult to see anything amiss. In addition to the Apple/IBM joint ventures Taligent and Kaleida, work at IBM's primary research centers in Yorktown Heights, New York, and Japan has resulted in gee-whiz products such as the ThinkPad pen-based computer and Ultimedia PS/2. Compaq recently announced a new peripherals division, enhancements to its DeskPro/M line as well as new computer lines, and a new triple-bus TriFlex architecture for its Systempro. Apple made a splash with its new PDAs (Personal Digital Assistants).

Even the big guys, however, are finding new revenue sources at the PC low end. For example, Compaq is counting on high-volume sales of its low-end ProLinea line yet is scrambling to produce machines fast enough to keep corporate buyers away from other companies' products. Despite its huge R&D budget, IBM needed Parallan's technology to bring it into the superserver market.

Companies with proportionately smaller R&D budgets must take a wait-and-see attitude. Lee Cannon, director of marketing at Acer America, said he could only speculate on whether the price war would soon result in decreased R&D spending at Acer. "We hope we reduce our costs and still keep our investments up to historical levels," he said.

"Toshiba's investment in technology hasn't slacked off a bit," said Steve Lair, vice president of marketing for Toshiba America's Computer Systems Division, "but we are being extremely careful about the investments we make in that they are targeted directly at customer requirements." And Gene Kunde, chief operating officer of Epson America, notes: "We have tried not to let today's economic reports impact our R&D efforts too much. We've not hit the panic button."

What helps some vendors are sugar-daddy parent companies. For instance, Zenith Data Systems got help in developing its new low-cost PC line from owner Groupe Bull, which has largely phased out its own PC business in Europe. NCR can conceivably get help from AT&T. And U.K. PC maker Apricot—the first company to release a 486 system in 1989—gets heavy R&D investment from Mitsubishi.

Part of the problem in assessing the extent of a company's R&D efforts is in judging the true nature of R&D figures on company balance sheets. "R&D is a flexible number," said Donald Collier, president of the Santa Barbara–based financial analysis firm ProLytix. "By your accounting methods, you can choose to put it as pure R&D or you can lump in engineering, which is more like cost of goods sold."

Marketing, Not Innovation

John Logan, an analyst for the Boston research firm Aberdeen Group, has noticed a shift in R&D funds to individual component makers and components, such as processors, chip sets, and RAM, and away from the vendors charged with building quality price-competitive systems. "Look at computer-magazine benchmark tests of 486 systems, and you'll see the performance differences growing smaller and smaller," he said. In other words, the same group of suppliers is providing components for virtually every system sold.

This leaves vendors with a myriad of options for how best to juggle OEM components into a well-designed system that can sell at a competitive price. It also sends them in two directions: improving service and support and introducing systems for specific niche markets, such as multimedia and network workstations, in an attempt to differentiate their product lines in an increasingly segmented market. ■

—Ed Perratore, with additional reporting by Andy Redfern, Gene Smarte, and Patrick Waurzyniak

NANOBYTES

At the announcement of Unix Systems Laboratories' System V release 4.2, which pundits are now calling the last chance for Unix (see "Is Unix Dead?" on page 134), USL president **Roel Pieper**'s (right) and Open Software Foundation president **David Tory**'s presence together signified a truce in the Unix world. The disarmament between the two companies comes in the form of concessions between USL and OSF. The next release of SVR4 will be made to comply with OSF's AES (Application Environment Specification); OSF's DCE (Distributed Computing Environment) is already compatible with SVR4. Looking further in the future, USL has agreed to support the ANDF (Architecture-Neutral Distribution Format) promulgated by OSF. □



Destiny Technology (Milpitas, CA), developer of ASICs (application-specific ICs) that accelerate and improve the output of laser printers, has extended its patented Edge Enhancement Technology to enhance the quality of all elements on a page, including text, line art, and halftone images. This single-chip solution will let printer manufacturers enhance their printers for less than $20 per unit. Output is good enough in some office applications to eliminate the need for using imagesetters, the company says. EET-X supports PostScript interpreters, PCL (Printer Control Language), and other imaging models and provides a perceived resolution of 2400 dpi for halftone images. When implementing either the ASIC's dual-frame-buffer approach or compression technology, images that would normally require 5 MB or more to be rendered would require as little as 1.5 MB. ■

Once Again, CA-SuperCalc's Numbers Crunched 'Em.

VARBUSINESS Spreadsheet Report Card 1992

	Average Score	Access Tech.	Computer Assoc's	Lotus	Microsoft
PRODUCT FEATURES					
Ease of use	7.01	6.70	7.00	6.81	7.52
Memory requirement	6.40	6.82	6.89	5.71	6.18
Ease of programming	6.48	6.33	6.58	6.32	6.69
Ability to manipulate data	7.35	7.60	7.29	7.00	7.52
Sorting capabilities	6.90	7.67	6.64	6.58	6.73
Provision for software security	5.65	5.87	5.67	5.32	5.75
Report writing capabilities	6.14	5.57	6.28	5.89	6.82
Ease of use of interface	6.82	6.75	6.70	6.18	7.63
Software integration capabilities	6.84	6.94	6.82	6.32	7.31
Ease of data retrieval	7.41	7.56	7.52	7.10	7.44
Satisfaction with product profitability	6.21	6.47	6.44	6.05	5.89
Overall quality of product	7.48	7.28	7.72	7.18	7.76
Product features average	6.73	6.80	6.80	6.37	6.94
SUPPORT FEATURES					
Provision for customer support	5.88	5.06	6.97	5.47	6.02
Charges for training time	5.17	4.38	5.95	5.05	5.29
Provision for technical support	5.76	5.20	6.60	5.40	5.85
Provision for marketing support	5.65	5.00	6.40	5.43	5.75
Documentation & product information	6.85	6.25	7.27	6.77	7.13
Frequency of updates & revisions	5.99	6.06	5.95	5.84	6.10
Support features average	5.88	5.33	6.52	5.66	6.02
OVERALL AVERAGE	6.45	6.31	6.71	6.13	6.63

VARBUSINESS
March, 1992

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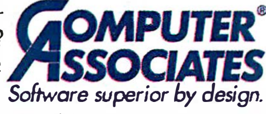
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RICH FRIEDMAN

RUSSIA'S PROGRAMMERS WAIT TO BE DISCOVERED

MOSCOW—Abaci outnumber PCs in the former Soviet Union by a wide margin. Depending on who's counting, there are between 700,000 and 2 million PCs scattered throughout the major cities and university towns of the CIS (Commonwealth of Independent States). High import duties, which run from 40 percent to 80 percent, coupled with a free-falling ruble and a shortage of hard currency (e.g., American dollars) have raised the price of a basic 286-based PC in the CIS to about $1100—what you'd pay for the next-generation 386 PC in America.

If PCs are scarce in the CIS, shrink-wrapped applications from big-name American software developers are even rarer. American companies have been reluctant to sell their programs in the CIS because, until recently, there were no copyright laws (in June, the Russian parliament passed its first software copyright-protection law, which, of course, only applies to Russia) and software piracy is rampant. To date, only 50,000 PC programs have been sold in the CIS, according to several sources. Programming languages from Borland and Lotus 1-2-3 are the best-sellers.

Understandably, because of the rapid political and economic changes sweeping the former Soviet Union, considerable uncertainty and apprehension were expressed by several attendees of the third ICF (International Computer Forum), Moscow's biggest computer show. A cross-section of about 16,000 mostly male academics, government officials, businesspeople, and scientists came to the computer show with a great hunger for any type of PC information. About 50 companies exhibited wares, ranging from an entrepreneurial university student selling a 5¼-inch disk that contained a graphical tour of the Kremlin to the latest Russian version of Borland's Turbo C++.

During the lunches and receptions, some of the attendees' fears and cynicism surfaced. One physicist told me that research projects in the CIS are being funded for periods of no longer than three months. A great deal of cynicism was also expressed regarding how the CIS would spend the billions of dollars of loans requested from the West.

Besides the nascent ICF, the best way for computer-interested folks in the CIS to exchange information is through user's groups. The largest in the CIS is BUGA, the Borland User Group Association, led by 37-year-old president Andrew Zotov. For the past two years, Borland has sponsored a software developer's contest throughout the Soviet Union. This year, 250 developers submitted entries. There is plenty of programming talent in the CIS, but it remains a well-kept secret, largely because of a lack of understanding of what is required to copyright, patent, and market programs abroad.

The winning application in this year's contest was FotoRobot, a program that lets you place and search on digitized photographs or sketches within a database. Yury I. Rassadkin, a lecturer at the Moscow State Technical University, headed the development team.



Masha, a program developed by the Ozero Association in Irkutsk to help English speakers learn Russian, captured second-place honors. Masha zeros in on five grammatical parts of Russian that are especially troublesome for non-native speakers: verbs of motion, verbs with reflexive particles, noun cases, verbs in the perfect and imperfect cases, and participles. The program highlights each grammatical point with multicolored pictures. Animated figures keep the student entertained.

The third-place winner, MACRO_DLL, provides a fully functional scripting language that developers can easily add to their Windows applications. The easy-to-learn language is a subset of Pascal. Once you have developed your application's basic functionality, you can use MACRO_DLL to send events, open dialog boxes, request information from the user of an application, and generally control your application from a set of easily modified scripts. MACRO_DLL was written by Anishenko Evgeny and Sushkov Vitaly from the Radiotechnic Institute of the Russian Academy of Science in Moscow.

These three programs are a fair representation of the many exciting programming ideas waiting to be discovered outside the CIS. With a little luck—and a lot of help—the CIS should begin to make an important contribution to the worldwide PC community. ■

Rich Friedman is an executive editor for BYTE. You can reach him on BIX as "rfriedman."

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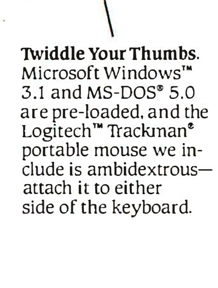
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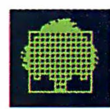
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ALAN JOCH

A FLIRTATION WITH INNOVATION

TAIPEI—Locals didn't seem to mind that the Canadians won Taipei's Dragon Boat Festival races in June, which this year coincided with Computex, Taiwan's largest computer exhibition and a showcase for foreign computer distributors. For a small country with a growing presence in the world market, placing second in the 2000-year-old race may have been nothing less than graciousness toward its international visitors.

The Dragon Boat Festival honors a poet who drowned himself to protest a corrupt emperor. The poet's friends threw rice dumplings into the water to feed hungry fish who might otherwise devour his remains. In a computer market that's constantly redefining "low-cost," Taiwanese manufacturers at Computex are like those ancient Chinese citizens: They're hurriedly packaging low-cost hardware to feed a demanding world.

At first blush, Computex, with its 150 exhibitors, seems like the computer shows in Las Vegas or New York. The largest and most glittering booths housed the island's leading vendors, such as Acer and Mitac. At an international pavilion, Micropolis erected a faux marble booth with white pebble walkways, and Intel flew large balloons outside the convention center to remind passersby that there was a computer show in town. (It was hardly necessary, however: At a traditional tea house miles away from the show floor, Chinese, Europeans, and Americans spread out computer spec sheets on the low wooden tables as they sipped the local oolong.)

Smaller and, in some cases, more innovative companies had modest booths consisting of little more than products and signs. Digging around these displays was sometimes productive. For example, Visionetics International demonstrated the VIGA+ Videographics card, a Targa-compatible graphics adapter. Sun Joy's multimedia subsystem included a SCSI connector, built-in speakers and microphone, and a CD-ROM drive. Primax showed the ColorMobile-424A, a hand-size color scanner with a motorized mechanism that pulls the unit down a page at the correct speed and without any side-to-side movement.

Unlike at other computer shows, getting basic product information at Computex can be difficult. Vendors resist quoting prices, especially early on in the show. This is because vendors prefer to wait until they find out what sort of prices their competitors are quoting. This elaborate ballet shows the extent to which price remains the main differentiator between Taiwanese products.

Sales figures bear this out. According to International Data Corp., Taiwan accounted for 6 percent of Asia's PC shipments in 1991. However, Taiwan received only 2 percent of the region's $15 billion in sales.

Even more telling are the facts that, in 1991, less than half the Taiwanese-sold PCs carried their own brand names, and the branded market grew by only 5 percent from the previous year. Taiwanese companies are still tied to international distributors that relabel systems.

Nevertheless, Computex vendors gave lip service to backing away from commodity products and clones in favor of technological innovation. New realities in the computer market are pushing Taiwan in this direction. Its PC vendors could survive on 4 percent profit margins when Compaq and other companies charged premiums for brand loyalty. But in the age of low-cost systems from first-tier vendors, Taiwan must find new ways to compete.

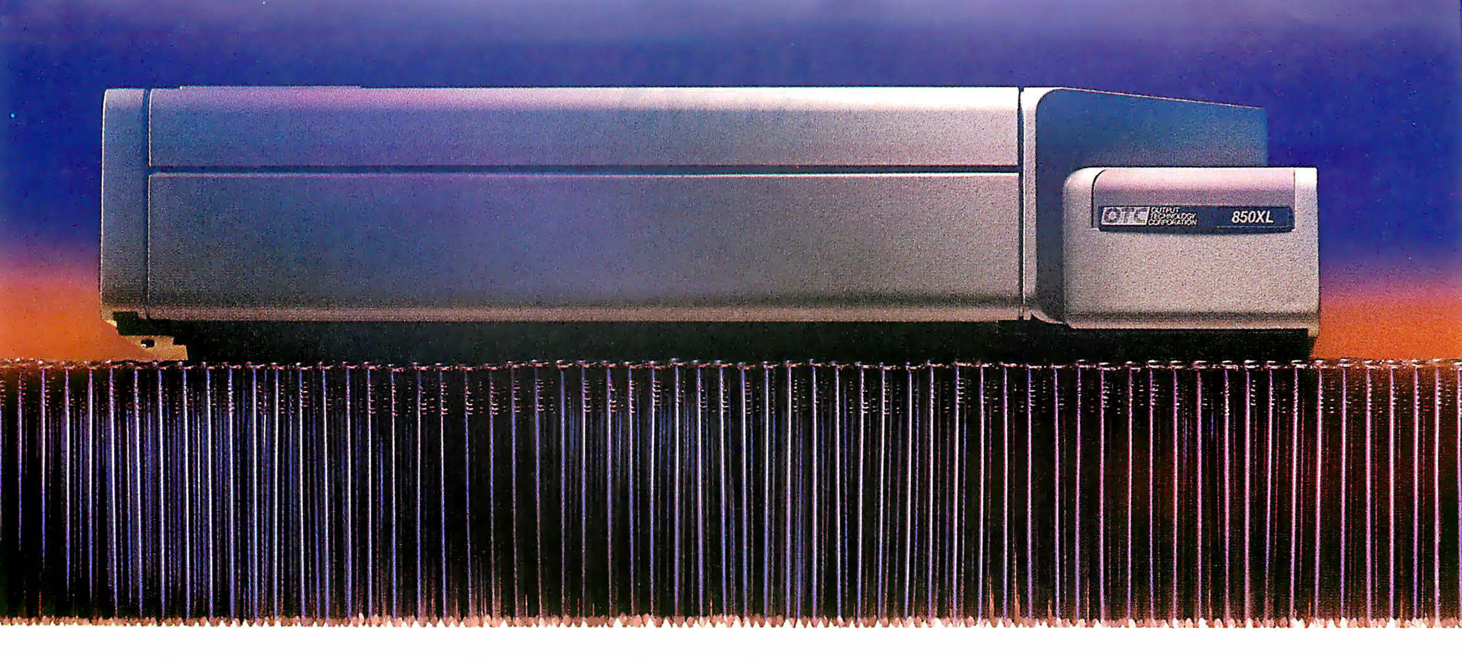
Taiwan continues its long journey toward innovation



Last year, Taiwanese computer companies spent only about $11.2 million for R&D. In addition, the government's industrial parks serve as models of how the computer industry might evolve. Three parks near Taipei are devoted to software or hardware development, and companies that build manufacturing operations in the parks are given tax breaks and employee housing.

But the proliferation of less expensive PCs and the fledgling nature of Taiwan's R&D mean the country's manufacturers will continue to compete on price for the time being. Some vendors at Computex said they're building ties to mainland China by establishing manufacturing plants there or sourcing commodity items such as VGA cards. Taiwan's mixed success in the late 1980s and the 1990s means that its low wages don't always provide an economic edge internationally. The challenge now is whether Taiwan can grow at the low end long enough to become a leader in innovative technologies. ■

Alan Joch is a senior editor and director of the BYTE Lab. You can reach him on BIX as "ajoch."



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AutoCAD Gets a Face-Lift

PATRICK WAURZYNIAK

The best-selling PC CAD software adds a GUI-like interface and speed enhancements

Nearly 175 enhancements and a more intuitive interface breathe new life into the dean of PC CAD programs. Cascading pull-down menus, programmable dialog boxes, and context-sensitive help bring GUI-like functionality to AutoCAD release 12, which remains essentially a DOS-based package. AutoCAD release 12 could help the fortunes of Autodesk, which now ranks as the world's sixth-largest PC software company following the drop in its stock value earlier this year. Autodesk is counting on the new features in release 12, such as support of SQL (Structured Query Language) and PostScript data exchange, to help the company broaden its horizons and open doors to markets outside its formidable strength in desktop CAD.

The new AutoCAD's improvements in terms of ease of use and raw speed became apparent as soon as I loaded the production-shipment version of the software. Installing it is a breeze with Autodesk's installation program. You should be aware, however, that AutoCAD makes significant demands on hardware in terms of memory and disk space, requiring at least 8 MB of RAM and about 25 MB for full installation of all program, help, and tutorial files.



With the newly integrated AVE Render feature's 3-D rendering capabilities, AutoCAD users can more easily create 256-color or full 24-bit, true-color 3-D visualizations of any 3-D drawing while working in AutoCAD release 12. This includes AME solid models.

My test machine was an AST Power Premium 4/50d (see the text box "AST 486 Packs an Expandable Punch" on page 47) with an Intel 486DX2 processor, 10 MB of RAM, and a 210-MB hard drive. Thus, running the new version of AutoCAD was no problem. Although Autodesk says the program will run on low-end 386 systems, my impression is that most users won't run AutoCAD without a reasonably fast 386 processor and the requisite math coprocessor, a generous amount of memory, and lots of free hard disk space.

A Quick Study on Proteus

When talking about the new GUI-like interface, one Autodesk executive likened release 12 to the Greek god Proteus, who was able to take on the characteristics of others yet still kept the same personality underneath. In fact, AutoCAD is supposed to adopt the face of the native environment on which it is running—be it a Mac, Windows, or a SPARC machine. Incidentally, with this program update, Autodesk for the first time simultaneously issued a new AutoCAD release for more than one platform, providing upgrades for both DOS-based PCs and Sun Sparcstations.

I was unable to verify whether the Proteus AutoCAD had such chameleon-like powers, because I ran release 12 only under DOS. Autodesk currently has two ongoing product developments, one for a release 12 running under Windows 3.1 with a Watcom extender product, and a version that will run under Windows NT.

With release 12's new interface, I found myself playing with the program even before bothering to open anything in the 45 pounds' worth of manuals accompanying the program and its companion products, Extension for Windows and AutoShade. Using the mouse, I found release 12 fairly easy to understand even before settling in on the documentation and a short stint with the on-line tutorial.

The release 12 software now greets you with the AutoCAD drawing editor screen, rather than the text-based main menu of previous versions. Most of AutoCAD's major commands can be invoked through clicking on release 12's pull-down menus, which cascade into smaller menus. Pop-up menus can be activated by pressing the Shift key and the right mouse button.

Integrated Rendering

Among the performance highlights, Autodesk says the program offers much faster

AST 486 Packs an Expandable Punch

Following an old strategy recently popularized by a host of competing PC makers, AST Research has once again produced an expandable line of PCs, the Power Premium 486, that is designed to give users virtually painless access to future CPU developments. AST has been manufacturing so-called expandable PCs since the advent of its Cupid-32 architecture almost four years ago.



I tested a top-of-the-line, Intel 486DX2–based AST Power Premium 4/50d, a small-footprint desktop EISA system optimized for Windows graphical environments. Sporting an integrated Western Digital accelerated graphics subsystem on the motherboard with 512 KB of VRAM (video RAM), which is expandable to 1 MB, the Model 213V test machine also came with an optional 210-MB hard drive and optional 14-inch Super VGA-LR monitor (which costs $545).

To run AutoCAD release 12, I had to add RAM to bring the 4/50d up to speed in meeting Autodesk's recommended 8-MB memory requirement. With the Power Premium line, AST touts an easy upgrade and expansion path, something I can indeed attest to: Adding 4 MB of memory to each of two SIMMs was simple. The 4/50d's cover, secured by three hand-tightened screws, popped off easily. Once I got inside, I could easily pull out the processor board, which can be populated with up to 16 MB of memory, from the motherboard to quickly snap in the SIMMs. The whole process took about 15 minutes.

With regard to expandability, the 4/50d's processor board conveniently offers an empty Intel Overdrive socket next to the DX2 processor into which you can later add Intel's clock-doubling chips to speed up older systems in the future. In addition, you can upgrade AST's Power Premium 386SX- and 386DX-based systems to the 486DX2 by inserting an AST Fastboard upgrade.

Aside from being blazingly fast, one of the AST machine's real strengths lies in its ability to quickly perform graphics operations. Using Western Digital's WD90C31 graphics chip with BitBlt and a hardware cursor, the 4/50d accomplishes Windows operations in a fraction of the time they take on 386-class systems. It moves windows without the usual flicker found on such systems with standard VGA graphics.

As for sheer CPU performance, BYTE's low-level DOS benchmarks showed that the 4/50d clearly outdistanced competing systems, such as the Tandon 486/25, while making machines like the Compaq Deskpro 386/25e look a bit long in the tooth. In short, the 4/50d is one system that likes to do Windows fast, while holding the promise of easy upgrades to next-generation processors in the future.

zoom and pan capabilities through the use of 32-bit vector space technology that virtually eliminates regenerations of drawings after you alter them. An enhanced Hide command uses virtual memory and an advanced algorithm to dramatically speed up hidden-line removal in AutoCAD drawings. I found this to be particularly true when doing regenerations on drawings that I had altered through additions or when removing the hidden lines.

One of release 12's nicest features is the integrated AVE (AutoCAD Visualization Extension) Render facility, which replaces the optional AutoShade 2 package as a way of doing basic rendering and shading of 3-D objects within AutoCAD. If you want more complex, photo-realistic 3-D renderings, you can buy the AutoShade 2 with Renderman package. This incorporates technology that Autodesk licensed from Pixar.

With the integrated Render command, I was able to generate 3-D visualizations of AutoCAD sample drawing files, such as a kitchen scene (see the screen), by just calling up a wireframe drawing and clicking on the Render menu at the top right-hand side of the screen. With Render selected, AutoCAD quickly processed 3-D renderings of drawings to a separate screen that can be captured in a frame buffer and saved in one of several formats, including

TGA, TIFF, and GIF. The speed of the rendering process varied between the drawings, but the kitchen scene took slightly over 2 minutes.

The AME (Advanced Modeling Extension) module has been improved. Version 2.1 has a new interface featuring pull-down menus and dialog boxes. The module also adds render support in which AME solid models that are rendered with the AVE Render feature are automatically meshed to produce higher-quality renderings.

With a list price of $3750 (a $250 increase over release 11), AutoCAD release 12 is not exactly an impulse buy. However, engineers requiring a serious full-fledged drafting package along with tools for mechanical modeling and 3-D visualization may find the program worth the hefty expense. ■

Patrick Waurzyniak is a news editor for BYTE in San Francisco. You can reach him on BIX as "patrickw."

THE FACTS

AutoCAD release 12
$3750
Advanced Modeling Extension, $495; AutoShade 2 with Renderman, $1000

System requirements:
A 386-based PC with a math coprocessor, 8 MB of RAM (11 MB is recommended), 11 MB of free hard disk space, DOS 3.3 (DOS 5.0 is recommended), an AutoCAD-supported video display and pointing device, and a plotter or printer-plotter.

Autodesk, Inc.
2320 Marinship Way
Sausalito, CA 94965
(415) 332-2344
fax: (415) 331-8093
Circle 1195 on Inquiry Card.

Power Premium 486
The minimum-configuration Model 3V systems include 4 MB of RAM, 512 KB of VRAM, and a 3½-inch 1.44-MB floppy drive; the Model 83V adds an 80-MB IDE hard drive; and the Model 213V adds a 210-MB hard drive. In the base Model 3V configurations, prices for the 50-MHz 486DX2-based Power Premium 4/50d begin at $3295; 4/50d Model 213V, $4095; 486DX/33-based 4/33d, $2995 and up; 386DX/33-based 3/33d, $2595 and up.

AST Research, Inc.
16215 Alton Pkwy.
Irvine, CA 92713
(714) 727-4141
fax: (714) 727-9355
Circle 1196 on Inquiry Card.

Can You Spot The Winner?



The Choice Is Black & White!



way 2000
The Winners Circle



Gateway 2000 employees were photographed for the summer fun ad at Atokad Park in South Sioux City, Nebraska.

The results are final — all those thoroughbred "favorites" outdistanced by a simple, determined, black-and-white cow! And once again, Gateway 2000 leads the pack to bring you new technology at down-on-the-farm prices.

We've incorporated Intel's new 66MHz DX2 clock-doubler chip, the fastest processor available today, in a reliable ISA machine with racing video and disk performance!



It's just one more big winner in our lineup of value-packed, high-performance systems. So give us a call and get in the Gateway 2000 Winner's Circle!




CASHIER
GATEWAY
WIN

Here's A Hot Tip: Gateway 2000 Is A Sure Thing!

Before you put your money down, study the statistics on the contenders. The current trend in the PC industry is to cut prices by stripping down systems and replacing quality components with inferior parts. Even companies with long-standing traditions of quality are doing it. At Gateway, we've never lowered our prices in response to market pressures. We've never needed to. And we'll never sacrifice features or quality to make prices look better. Our race strategy has always been to offer the best price, quality and service in the market.

Price

Gateway's price advantage is simple business economics. We have huge volume buying power. The little guys don't. We have low overhead. You don't pay for glass palaces with us. And we operate on conservative margins. While we've grown big and strong on these rations, our margins are a starvation diet for some of our competitors. We lower prices whenever we can. And we've been quietly doing this since day one.

Quality

When surveyed recently by *PC Magazine*, Gateway customers gave their systems the **highest reliability rating** among 35 of the nation's top PC manufacturers. That's certainly an indication that our great prices aren't a trade-off for quality or performance. Gateway systems are loaded with top-of-the-line components and performance features. We know you don't want a cheap computer. You want a great computer at a great price. You want a Gateway!

Service

We know how important service is to you. That's why we're constantly working to provide the best in the business. Service is one of the reasons we received the **highest customer satisfaction rating** in *PC Magazine's* service survey. Gateway scored "significantly better than any other manufacturer" when PC users were asked, "Would you buy again from the same manufacturer?"

Price. Quality. Service. This simple formula still equals the best value in the industry. Add Gateway's ability to bring you the latest technology at the best prices, and you have a triple-crown winner. So put your money on a sure thing. With Gateway 2000, you're guaranteed to come out a winner!





Gain The Winning Edge With 486 Performance

Gateway's powerful 486 models give you the winning margin! And when you recap our new price reductions and compare us feature-for-feature against other runners, you'll find you won't even have to play your hunches — Gateway 2000 is the odds-on favorite.

25MHz 486SX

■ $1895

This is the hottest value on the market! You get 486 technology, including an 8K internal cache and burst mode, at a 386 price. And besides being faster than any 386 on the market, the 486SX/25 is upgradeable to 50MHz if you need increased performance in the future.

33MHz 486DX

■ $2395

We recently increased performance and lowered the price of our best-selling, award-winning 486DX/33 by adding an ATI™ Graphics Ultra video card and a faster, 200MB Western Digital hard drive with 13ms access time. At $2,395, the price/performance ratio on this machine is hard to beat. Plus, you can upgrade this system to 66MHz.



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■ **$2695**

Gateway 2000's new 486DX2/50 systems, ISA and EISA, incorporate Intel's speed-doubler technology. The internal core of the DX2 processor executes at 50MHz while communicating with the external memory bus at 25MHz. Our benchmarks show a 35% increase in performance over a 33MHz 486DX.

This system also has the new, faster Western Digital 200MB hard drive and the high-performance ATI Graphics Ultra video card.

50MHz 486DX2 EISA

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Our EISA system comes standard in a floor-standing tower model, and includes a large, fast SCSI drive and an EISA SCSI controller as standard equipment. RAM cache is expandable to 256K.

66MH 486DX2

■ Call for details.



Gateway 2000 systems come fully configured with all the performance features you want, including two floppy drives, a programmable 124-key AnyKey™ keyboard, a Microsoft® mouse, MS-DOS® 5.0, Windows™ 3.1 and your choice of one application software option. See the back pages of this ad for complete configurations and information about software options, upgrades and peripherals.

486 SYSTEMS


rules Chicago

GATEWAY 2000 NOTEBOOKS PUT YOU IN RACING FORM

The Nomad Series

Our small, lightweight Nomad notebook computers let you take desktop computer performance anywhere you go. Nomad models come with VGA graphics, a FieldMouse™ (portable pointing device), built-in floppy drive, and an 80 or 120MB hard drive, depending on the model. A patented power-management system gives you hard-to-beat battery life benchmarks — over six hours of operation from a single battery on the 25MHz 486DX system!

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All these features ... and the Nomads are made in the U.S.A.!



Nomad 325SXL ■ $1995
25MHz, 386SXL processor
■ 4MB RAM ■ 80MB hard drive

Nomad 420SXL ■ $2695
20MHz, Intel® 486SXLP processor
■ 4MB RAM ■ 80MB hard drive

Nomad 425DXL ■ $3495
25MHz, Intel 486DXLP processor
■ 4MB RAM ■ 120MB hard drive

For The Power User On The Go

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Since the Nomad 425DXL has all the power of a 486DX desktop system, it's the ideal portable/desktop combination system! Save with this combo package!

Combo Highlights: Nomad 425DXL ■ 15" CrystalScan 1572FS color monitor ■ programmable 124-key AnyKey™ keyboard



The HandBook™

If you like to travel light, you can't go wrong with the HandBook. It weighs only 2.75 pounds and measures roughly 6 x 9 inches — smaller than this magazine! Yet it has 286-class performance and real PC features including a bright, backlit screen, a bonafide 40MB hard drive and a comfortable keyboard (no chiclet keys). Downloading information from your HandBook to your office computer is easy with the serial cable and file transfer software provided.

HandBook ■ $1295

For The Executive On The Go

HandBook Combo ■ $3995

Combine the portability of our HandBook with the power of our 33MHz 486 desktop system with communication capabilities — and you have a terrific combo, Gateway value-priced!

Combo Highlights: HandBook with 2,400 bps external modem and communication software ■ 33MHz 486DX system with 120MB IDE hard drive ■ TelePath™ fax/modem package



Gateway 2000 Adds A Free Software Bonus

Choose Your Free Software Option

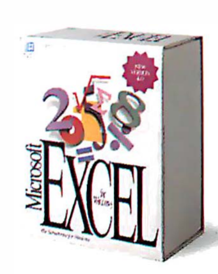
With the purchase of any Gateway 2000 mini desktop, desktop or tower computer system, you receive your choice of one application software option at no additional cost. We'll install your software on your hard drive, optimally configured for your system and Windows, and provide master diskettes and manuals. You may also purchase a second application software option, pre-installed, at extremely competitive prices.

Installation and setup errors are responsible for over one-third of all software problems. You can eliminate that possible source of problems by purchasing your system from Gateway with software pre-installed, tested, and ready to run the moment your system arrives. Add that advantage to the hard-to-beat prices, and Gateway is the only logical choice for PCs and software!

Choose one of the following application software options:

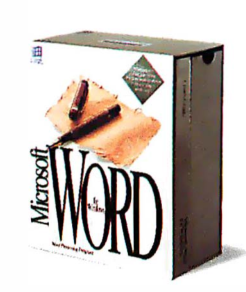
Option #1-*Microsoft Excel for Windows™ 4.0*

■ New version of this powerful spreadsheet, includes online help for *Lotus 1-2-3®* users



Option #2-*Microsoft Word for Windows™ 2.0*

■ Best-selling word processor for Windows. New version 2.0 adds online help for *WordPerfect®* users



Option #3-*Microsoft PowerPoint for Windows™ 3.0*

■ Easy-to-use desktop presentations program creates high-quality overheads and 35mm slides



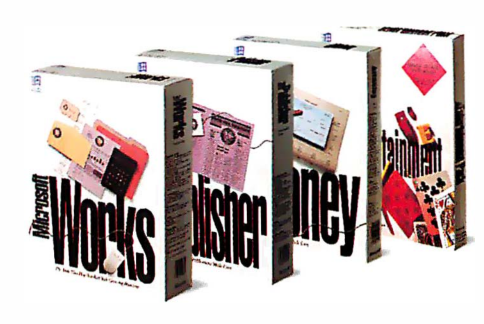
Option #4-*Borland® Paradox® 4.0*

■ The award-winning database from Borland



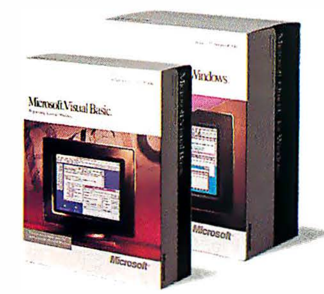
Option #5-*The Entrepreneur Pack*

■ Includes the latest Windows versions of *Microsoft Works*,™ integrating word processing, spreadsheet, and database in one easy-to-use program; *Microsoft Publisher*,™ for creating page layouts; *Microsoft Money*,™ to help you write checks, set budgets, track expenses; PLUS an *Entertainment Pack* with eight games, including *Tetris®*





Option #6- *The Windows Programmer Pack*



■ Includes everything you need to create programs for Windows: *Microsoft QuickC for Windows*,™ *Windows Control Development Kit*,™ *Windows Help Compiler*™ and *Windows Programmers' Online Reference*.™

Option #7-*Microsoft Project for Windows*™ *3.0*

■ Flexible and easy project management program



NOTE: If you would rather replace an option with *Microsoft Office*,™ it is available for $175. This package includes *Word for Windows*, *Excel* and *PowerPoint*.

More Software At A Great Price!

The following applications are only available with the purchase of a system, pre-installed, or to Gateway customers.

Central Point® Anti-Virus 1.2 For Windows ■ $75

Central Point Backup™ 7.2 for Windows ■ $75

The Norton Desktop™ 2.0 and Prisma Your Way 2.0 For Windows ■ $95

These offers include the identical applications contained in retail packages but will not include the retail box. You get all master diskettes and manuals, shrink-wrapped and packaged in a Gateway 2000 box.



Peripherals

The 15-Inch CrystalScan 1572FS



You'll enjoy your new Gateway 2000 computer even more if you choose the new 15-inch CrystalScan color monitor option. The CrytalScan 1572FS has a flat, square, non-glare screen to reduce distortion around the corners and provide edge-to-edge display area. The CrystalScan 1572FS is an upgrade option only with the purchase of a 386DX or 486 system for an additional $195.

The Gateway 2000 TelePath™ Fax/Modem

The Gateway 2000 TelePath is a 14,400 bps mode, V .32bis, with 9,600 bps fax capability. The TelePath comes with WinFax Pro,™ Crosstalk™ for Windows, Qmodem™ and a free 30-day basic services CompuServe® membership — all for only $195!

■ Fax mode: V.17, V.29 and V.27ter

■ Data mode: V.32bis, V.32, V.22bis, V.22, V.21, Bell 212A and 103, V.42 and MNP 2-4 error correction, V.42 bis/MNP 5 data compression

Included With Every System:

■ One-year limited warranty ■ 30-day money-back guarantee ■ Lifetime toll-free technical support ■ Free on-site service to most locations (*factory service only for notebooks*) ■ Free bulletin board technical support ■ C.O.D. terms and major credit cards honored ■ Net 30-day credit terms and leasing options available to qualified commercial customers

Sorry — we sell peripherals only with the purchase of a Gateway 2000 system, or to people who are already Gateway 2000 customers. For fastest service, call our new direct line for the ***Component Add-On Division: 800-252-3333.*** *Please have your customer ID handy when you call.*



GATEWAY 2000 WINNERS CIRCLE

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NOMAD 325SXL
- 25MHz, 386SXL Processor
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- 7-Hr.* NiCad Battery & AC Pack
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- 79-Key Keyboard
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$1995

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- 1 Parallel/1 Serial Port
- 79-Key Keyboard
- FieldMouse Pointing Device
- MS DOS 5.0 and Windows 3.1

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NOMAD 425DXL
- 25MHz, Intel 486DXLP Processor
- 4MB RAM
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- 120MB IDE Hard Drive
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- Simultaneous Video with 1MB
- Size 8.5" x 11" x 1.8", 5.8 Lbs.
- 6-Hr.* NiCad Battery & AC Pack
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- 79-Key Keyboard
- FieldMouse Pointing Device
- MS DOS 5.0 and Windows 3.1

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25MHz 386SX
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- 14" CrystalScan 1024 Color VGA Monitor
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- MS DOS 5.0 and Windows 3.1
- Choice of Application Software

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- 120MB 15ms IDE** Cache Drive
- ATI™ Graphics Ultra Video
- 14" CrystalScan 1024NI Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 124-Key AnyKey Keyboard
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- MS DOS 5.0 and Windows 3.1
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33MHz 486DX
- Intel 486DX Processor
- 64K Cache RAM
- 4MB RAM
- 1.2MB & 1.44MB Drives
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- ATI Graphics Ultra Video
- 14" CrystalScan 1024NI Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 124-Key AnyKey Keyboard
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- MS DOS 5.0 and Windows 3.1
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50MHz 486DX2
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- 64K Cache RAM
- 8MB RAM
- 1.2MB & 1.44MB Drives
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50MHz 486DX2 EISA
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- Microsoft Mouse
- MS DOS 5.0 and Windows 3.1
- Choice of Application Software
- Tower Model is Standard

$3695

66MHz 486DX2
- Call for details

** Battery life was measured using PC Magazine's Battery Rundown Test with power management enabled. Actual results may vary depending on configuration and applications.*

All prices and configurations are subject to change without notice. Prices do not include shipping. Components, peripherals and software are sold only with the purchase of a system, or to customers who already own Gateway 2000 systems. Some limitations apply.


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Acquiring Data Through Windows

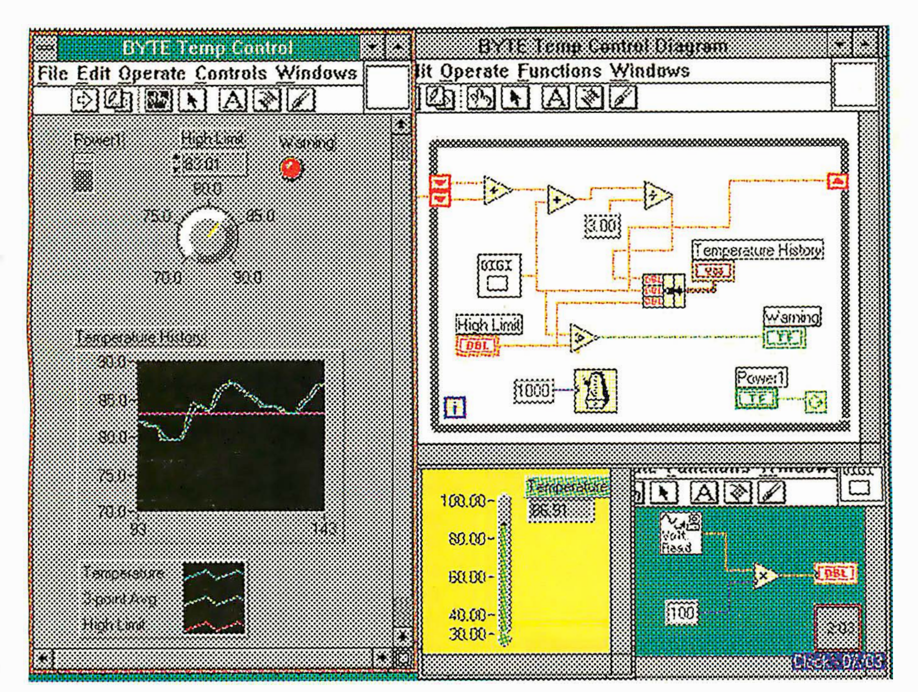
ANDY REINHARDT

LabView for Windows uses advanced visual programming, but the learning curve is steep

Data acquisition has come a long way since the days of the DEC MINC. The arrival of add-in cards for the Apple II and IBM PC in the early 1980s heralded a lower-cost, more personal approach to collecting and analyzing laboratory data. Ever since then, microcomputer-based data acquisition systems have gotten more sophisticated—although not necessarily much easier to program.

The new LabView for Windows from National Instruments marks yet another turning point for data acquisition: The software not only is incredibly powerful within its niche, but is also a leading example of the industrywide trend toward visual programming. This package lets you design complex real-time data collection and analysis routines using only icons, without typing a single line of code. Although it's not the only such software for data acquisition, LabView may be the first that does not sacrifice flexibility and configurability in the name of ease of use.

As with other nonprocedural visual programming tools, however, there is a price to be paid for LabView's approach: The learning curve is steep to create even a simple procedure, such as reading a voltage and displaying it on a graphical strip-chart recorder. And when your procedure gets very sophisticated, structuring and debugging the application can become fiendishly difficult.



LabView uses a CAD-like technique that lets you draw your data acquisition application. In this example, the instrument panel on the left is driven by the diagram on the right. The Digi icon encapsulates the display and diagram at the bottom right.

Getting the Data

Applications for data acquisition range from biological research in university labs to materials testing at auto makers. Because these uses vary so widely, the hardware and software tools to automate data acquisition must be general, yet specific enough to obviate custom programming.

The typical data acquisition setup includes transducers that measure real-world phenomena (e.g., temperature, pressure, and light) and convert them to voltage. The sensors are wired to A/D conversion hardware, either a stand-alone instrument that outputs formatted digital signals—RS-232 or GPIB (general-purpose interface bus)—or a card installed in the backplane of a PC, Mac, or workstation. Many applications also include TTL-level digital inputs. Data acquisition software packages need to support these basic I/O functions with precise timing control.

Once acquired, digital data is usually stored in stored in RAM and/or saved to disk, displayed on the screen, and analyzed in real time or off-line. The software must create data arrays, support rich graphics, and include mathematical and statistical functions for data analysis. In some automated research applications, the computer also controls actuators that open and shut valves, start and stop motors, or turn on lights.

LabView for Windows is designed to work with the wide array of A/D and D/A hardware sold by National Instruments, as well as with serial and GPIB instruments from companies like Hewlett-Packard and Fluke. It does not directly support third-party boards. The minimum computer necessary to run LabView is a fast 386 PC with a math coprocessor, 5 MB of RAM, 15 MB of free disk space, Windows 3.1, and a mouse. A color display and a printer are desirable.

Because Windows is not a real-time operating system, National Instruments

includes with LabView virtual drivers for DMA and interrupt service that replace those supplied with Windows 3.1. These alone won't make Windows a preemptive multitasker, but assuming that the acquisition hardware samples data at precise intervals and stores it in a buffer, LabView's drivers ensure that data gets routed to the system before it is overwritten.

The Virtual Instrument

LabView for Windows is designed around the notion of the *virtual instrument*, which is a pictorial representation of an instrument's front panel. The power of LabView is that you can create a data acquisition application largely by designing what you want it to look like. Implicit in this approach is an object orientation, because the screen icons represent functions whose inputs and outputs you also specify graphically and that, once defined, can be reused.

When you load LabView, you start with a blank page onto which you drag icons that symbolize controls (e.g., knobs, slider bars, and user input fields) and readouts (e.g., numerical LEDs, bar charts, and alarm indicators). As each component is added to the display screen, a schematic of it is simultaneously added to a matching diagram that parallels the virtual instrument. To create the relationships between the components of the display, you link them (or *wire* them) on the diagram.

For example, you could start by selecting a graph display icon for the virtual instrument. On the diagram, this graph will show up as an output. You must then specify the source of the data that will be pumped into the graph by selecting the actual instrument (i.e., card location and port or device and channel). When these two icons are connected using the wire tool, the software connection is made as well. If you want to amplify the voltage by 100 before delivering it to the graph, you drop in a multiplication icon and a constant and rewire the drawing.

In more complex displays, you can select from hundreds of icons for numeric values, Boolean readouts and switches, strings, arrays, graphs, and decorative elements. On the diagram, you can select constants, math functions (e.g., arithmetic, trig, and log), comparators, programming constructs (e.g., FOR loops), strings, arrays, data-conversion routines, and specialized analytical tools (e.g., signal processing, linear and nonlinear filtering, and regression). The diagram menus also give access to file and data I/O functions.

Setting up applications in LabView involves creating layers of displays and diagrams, which can be encapsulated into icons. This is where the object orientation comes into play. The display you see when running an application is only the top layer. Below that is the diagram, which can contain icons that are themselves defined in other display/diagram pairs. Once a sequence is defined, you can design an icon for it and add it to the library. For example, in the screen, the diagram in the bottom right-hand corner belongs to the display

BEFORE PROTECTING YOUR SOFTWARE...

SEE US AT COMDEX/Fall '92

...against piracy and unauthorized use, make sure that your protection system has all the following qualities:

A GOOD HARDWARE KEY

Hardware-based software protection systems are now the standard worldwide. However, not all keys are the same. A good key should have all the following features:



✔ Compatibility and transparency. The key should work without any problem on your customers' computers. The user should be able to forget the key after connecting it.

✔ Unbreakable electronics. A customized ASIC (Application Specific Integrated Circuit) component should be integrated in the key. This prevents reverse engineering and makes cracking virtually impossible.

✔ A unique and inaccessible software developer's code burnt into the ASIC. (This code should not be held in the key's memory, where it can be read and altered.)

✔ A Read/Write Memory inside the key should be available on demand. The memory should be writable in the field, on any PC, without any special programming equipment.

✔ Very low power consumption, enabling the key to work even under the worst power conditions, on PCs and laptops, with or without a printer.

POWERFUL SOFTWARE

Since it's practically impossible to crack or duplicate a key having all the features mentioned above, a pirate will usually go for the software linking the protected program to the key. Therefore, check that your protection software has all of the following:

✔ A Linkable Protection Module with which calls can be made to the key from any point in the protected program.

✔ An "Envelope" installation program. Such programs enhance security while making it possible to protect a software even without its source code.

✔ Sophisticated antidebugging and encryption mechanisms.

HASP®, THE PROFESSIONAL SOFTWARE PROTECTION SYSTEM, OFFERS YOU ALL THESE FEATURES AND MORE:

HASP was designed by a team of computer experts, professional cryptologists, and electrical engineers. As a result, HASP keys are supported by what is probably the best software in the market, and the HASP system has worked on every computer it has been tried on. In addition to all the features mentioned above, HASP provides:

✔ A Full Authorization System for protecting dozens of programs using only one key.

✔ A Pattern Code Security System (PCS) enabling parallel processing of multiple calls by the Linkable Protection Module.



✔ A Virus Detection option that can be incorporated in the protected program to check whether it has been infected by a virus or tampered with in any way.

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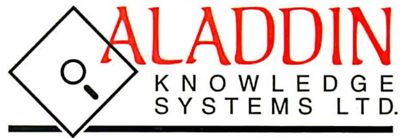
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* CT Magazine, May 1990.

Design: Ilan Peeri

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next to it, which, in turn, defines the Digi icon in the active window.

If all this sounds a little overwhelming, it is. National Instruments has made the job of getting started with LabView a bit easier by providing examples, a good tutorial walk-through, and canned icons for basic activities (e.g., reading a voltage). But the fact remains that it is probably more difficult to set up a simple application using LabView than with procedural code. As with any program, some of the learning curve is semantic and syntactic, but much of it has to do with the *inherent invisibility* of the layers of diagrams and the nonprocedural flow of the program.

Making even a simple change to a diagram diagram (e.g., adding a second plot to a graph) involves complex steps, such as including a shift register in the program loop and a bundle icon to group multiple inputs into a single graph. Some diagrams involve dozens of icons, and each may have been separately defined. To change them requires drilling down through many layers to find the right diagram. Also, the user interface was at times inconsistent.

On the other hand, LabView is remarkably powerful and complete. Although an API is available for accessing external code modules, few applications will require this because practically any data acquisition process can be designed graphically. LabView also includes debugging features that make it possible, for example, to find the source of a data value, set breakpoints, step through a block diagram, and highlight the sequence of execution.

Despite having been designed specifically for data acquisition and control, LabView for Windows is a shining example of visual programming. Setting up a data acquisition procedure is not much different than writing any event-driven program, and the model employed by LabView allows for reusability and freedom from coding, as well as a high degree of complexity. This package deserves to be considered by anybody involved in data acquisition—as well as by anybody eager to study a sophisticated example of state-of-the-art visual programming tools. ■

Andy Reinhardt is BYTE's West Coast bureau chief. He can be reached on BIX as "areinhardt."

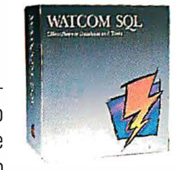
THE FACTS

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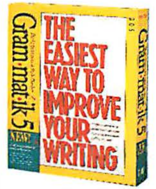
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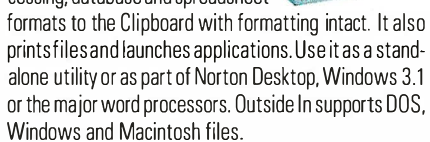
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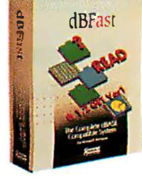
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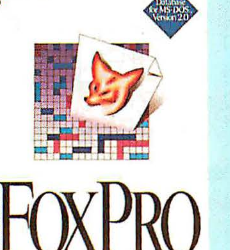
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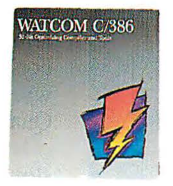


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The Olivetti Quaderno: A New Voice In Portable Computing

LONDON—Perhaps the most interesting aspect of the **Olivetti Quaderno** is the integration of a DSP (digital signal processor) into the basic design, providing some limited support for speech. The 8086-based subnotebook is a 2¼-pound DOS-compatible machine with a 20-MB hard drive. The machine is packaged in a stylish case, and its proportions are similar to those of a hardback book; it is approximately 8 inches wide, 5 inches deep, and just over 1 inch high.



The top of the case has a cutout for a small LCD screen that shows the time and some system status features. Six buttons (i.e., stop, pause, play, record, fast forward, and rewind) control the speech module while the Quaderno is still closed. This lets you create speech memos in those situations where you have insufficient time to open the machine and type the information in.

Along the right side of the case are a number of connectors and controls, including serial, parallel, and headphone connectors; a reset switch; and a speaker volume control. The serial and parallel ports are of the mini-DIN-8 variety, but the manufacturer does include a cable converter. The only other external feature is a PCMCIA 1.0–compatible slot.

Opening the clamshell-style machine reveals an unusual keyboard and a mediocre 7-inch screen with support for eight levels of gray. The screen isn't backlit, and, although it supports Olivetti's 640-by 400-pixel super CGA mode, I found that it was difficult to read in all but the best light.

The 93-key keyboard layout is similar to the standard Toshiba layout except that the up-arrow key is located between the Slash and Shift keys. This was done to leave the arrow keys in the familiar inverted T shape. But by moving the Shift key, Olivetti has made the keyboard difficult to use. Using both this keyboard and a normal keyboard regularly could be confusing. Above the main keyboard is a useful soft-key numeric keypad. The on/off switch is located to the left of the numeric keypad and has a raised ridge around it to prevent accidental activation.

Internally, the machine is designed around the 16-MHz NEC V30HL 8086-compatible processor. It has 1 MB of RAM, of which 384 KB is configured as expanded memory. The DSP is provided by Analog Devices, and future Olivetti machines may well provide additional functionality through the DSP. Currently, only a speech module is provided, which creates speech files compatible with a number of other vendors who use the Analog Devices DSP. The files are not compatible with Sound Blaster files, and no conversion utility is available yet.

The Quaderno's power comes from a rechargeable nickel-cadmium battery pack, although six standard AA batteries can be used if needed. Battery life varied depending on the processor speed selected and whether the serial port was used, but around 10 hours seems to be the average.

The Quaderno ships with DOS 5.0 installed and includes a configurable suite of utilities written by Olivetti. The software includes a notepad, calculator, schedule, phone book, file manager, voice memo manager, and configuration program. The facilities are basic, and I found that I used only the voice memo manager and the configuration program with any regularity.

The voice software is a good but rudimentary first attempt. It simply lists recorded messages in order, with timings noted in seconds. Individual memos can be selected and played back. I'm looking forward to future machines that use the Analog Devices DSP a bit more fully.

Upon installing a copy of Quarterdeck's Desqview, I found some problems with Olivetti's keyboard driver. The Desqview pop-up key did not operate, and Desqview's useful Ctrl-Alt-Del trapping mechanism failed, too. This left Desqview severely crippled.

Testing this machine revealed some interesting problems with Microsoft's notebook power management software. Running an identical Quattro Pro spreadsheet recalculation on the Quaderno and a slower Toshiba T1000XE revealed that the recalculation took eight times longer on the Olivetti machine.

After some investigation, I discovered that the power saver's processor pause period interfered with the background processing that the recalculation routine used. To remedy the situation, I had to disable the power saver, reducing the potential battery time.

The Quaderno has many virtues, including size, weight, and performance. However, I was left feeling that the software for the system was a rough cut and that future versions of the Quaderno and other additions to Olivetti's subnotebook range would provide refinements to the seemingly rushed software.

—Andy Redfern

THE FACTS

Olivetti Quaderno
about $1300 (£680)

Olivetti Italy
Ing.C. Olivetti and C., S.p.A.
20121 Milano
Vicolo S. Giovani Sul Muro, 1
Italy
39-2-8836-2213
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A4 Notebook Reveals Acorn Is ARMed and Ready



LONDON—When U.K. system manufacturer Acorn developed a machine based on a processor it had designed itself, few gave the company much chance of surviving. Acorn, an Olivetti subsidiary, developed the 32-bit ARM (Advanced RISC machine) processor to replace the 6502 used in its previous machines. Now that Apple has announced its intention to use the ARM processor in its Newton products, ARM-based systems are taking on new appeal.

Acorn Computers' latest machine is an ARM-based notebook to complement its desktop Archimedes line. The new notebook, called the **Acorn A4**, comes in two variations. The entry-level system has 2 MB of RAM and a 2-MB floppy drive; the high-end model has 4 MB of RAM and a 60-MB hard drive. Both machines run version 3.0 of Acorn's proprietary RISC OS graphical operating system, but they can also run DOS programs by software emulation.

The A4 has an edgelit LCD screen with VGA resolution of 640 by 480 pixels and 16 levels of gray. The system features an 83-key U.K.-style keyboard, and there are connectors for an external analog RGB monitor and an AT keyboard. A serial port and a bidirectional parallel printer port are fitted, but for unknown reasons, the latter will not support LapLink. The A4 weighs 6¾ pounds, a quarter of which is due to the massive rechargeable nickel-cadmium battery pack. Despite the size of this pack and the use of power-saving design techniques, it provides a disappointingly average 2½ to 3½ hours of use.

The system comes with a three-button conventional mouse, although in cramped spaces you can emulate a mouse by using the special Fn modifier key with the *Q*, *W*, *E*, and cursor arrow keys. There's a neat LCD fuel gauge–type battery indicator below the keyboard. The separate AC power unit trickle-charges the batteries during normal use and can handle any nation's supply voltage.

Driven by a 12-MHz ARM3 RISC processor capable of 12 MIPS, the machine is roughly the equivalent of a fast 486 PC or a high-end Mac in terms of computing power. The 2 or 4 MB of RAM is contiguously addressable and is managed by Acorn's sophisticated MMU (memory management unit) chip, which lets you allocate more memory to applications or to system resources interactively at run time.

The RISC OS operating system is held in 2 MB of ROM, with a windowing GUI and a set of core applications; bit-map, vector graphics, and font editors; and a powerful, structured BASIC. Long before Microsoft Windows 3.0 or Apple's System 7.0 appeared, RISC OS featured a fully multitasking, windowing interface with support for data types such as antialiased outline fonts and stereo sounds in a more integrated way than either competitor.

The A4 is a formidable portable-computing platform when running RISC OS applications like the excellent Impression desktop publishing system. It outstrips the PowerBook 170 in terms of raw CPU speed and video and graphics performance, but the choice of software is limited. My only serious criticism is that the mouse cursor was far less visible on the gray-scale LCD screen than on the color screens to which I'm accustomed, and it tended to get lost when moving rapidly. However, you can use RISC OS's global palette control to improve matters somewhat by assigning the cursor full-intensity white while dimming your applications' backgrounds to a light gray.

The optional Acorn PC Emulator program creates what appears to be an ordinary DOS 3.3 session within a RISC OS window, and its fidelity is good enough nowadays to run Flight Simulator, Lotus 1-2-3, Sidekick Plus, and even Microsoft Windows. The snag is that even the nippy ARM processor takes a big hit when software-emulating an 8086. Thus, DOS performance is at the level of a slow 286.

However, you can run text-based DOS applications like word processors very well, and there are good cut-and-paste facilities between DOS and RISC OS; you can cut screens as either text or bit maps and paste them straight into RISC OS without the need to store an intermediate disk file. RISC OS can read and write DOS-format floppy disks.

The A4 will appeal mainly to existing Archimedes users. It's reasonably priced for its power when running RISC OS, but it would not be a sensible purchase merely to run DOS. However, Apple's support of the ARM processor may make Acorn a company to watch.

—Dick Pountain

THE FACTS

Acorn A4
with 2 MB of RAM and a 2-MB floppy drive, about $2675 (£1399); with 4 MB of RAM, a 2-MB floppy drive, and a 60-MB hard drive, about $3225 (£1699)

Acorn Computers
Fulbourn Rd.
Cherry Hinton
Cambridge CB1 4JN
U.K.
44-223-245200
fax: 44-223-214382

Acorn Computers Canada, Inc.
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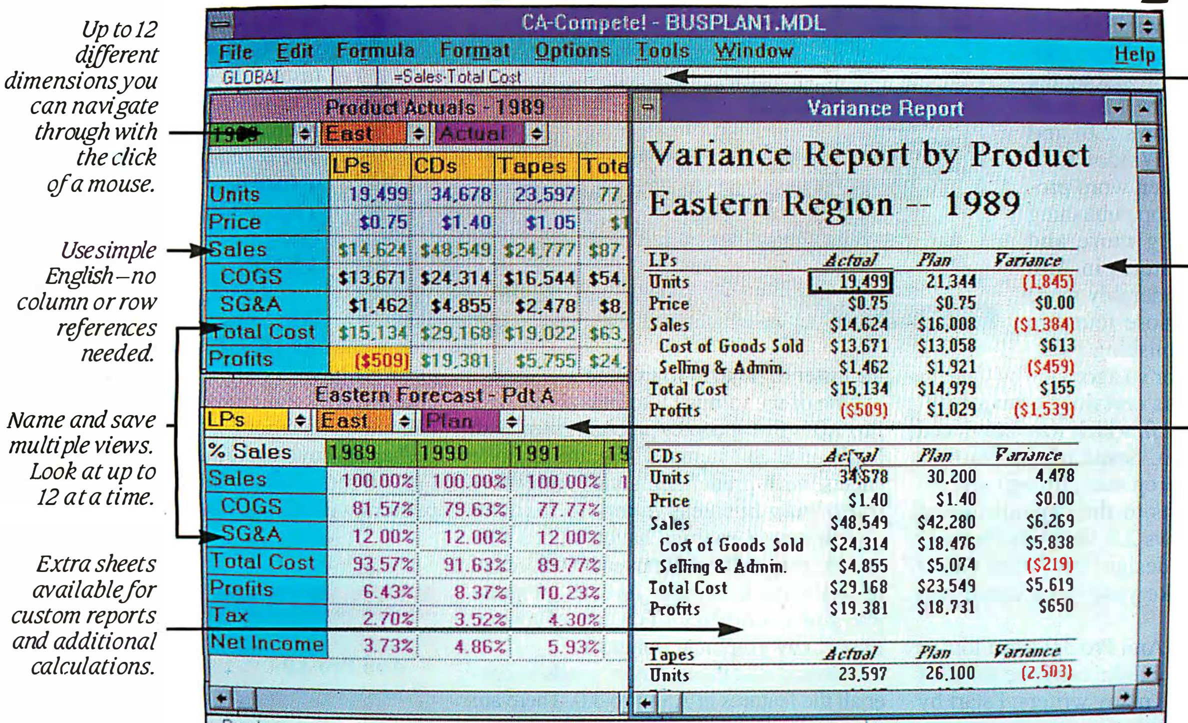
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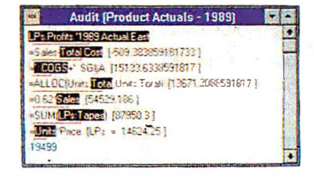
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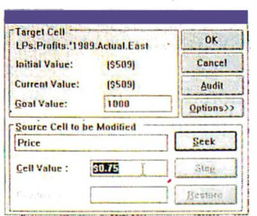
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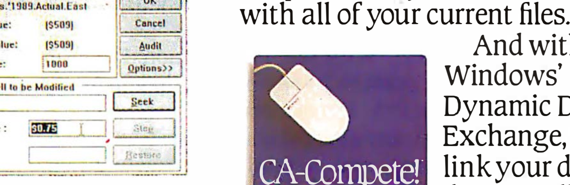
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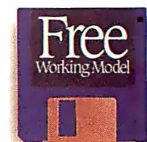
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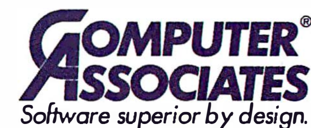
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Ami Pro 3.0 Sets a New Standard

I'm dating myself when I say that I remember when computer word processing meant putting plain ASCII text on the screen. To put it mildly, things have changed. **Ami Pro 3.0,** the latest entry in the explosive battle of Windows high-end word processing packages, ups the ante in the fight among the Big Three: Ami Pro, Microsoft Word for Windows 2.0, and WordPerfect for Windows.

The line between word processing and desktop publishing is fast becoming more and more blurry. Features in Ami Pro 3.0 are considerably more advanced than those found in true desktop publishing packages just a year or so ago.

Ami Pro 3.0 is certainly a major upgrade to version 2.0, which was introduced about a year ago. Some of the features (e.g., drag-and-drop text editing) are obviously reactions to the capabilities of Word for Windows 2.0. But Ami Pro goes beyond reactive design. It's full of clever features that make your work easier and faster.

My reaction to Ami Pro 3.0's fast format ability was, "Why didn't anyone think of this before?" Like many writers, I start by putting all the words down on the screen. I go back and worry about the look and feel later. With other packages, changing text attributes (e.g., bold and italic) or fonts is a multistep process of marking the text and using multiple menus or icons to choose the look and feel. With fast format, all I need to do is point to some text and click on a key. Ami Pro "remembers" the format. I can then go anywhere else in the document, mark text, and instantly change it to match that earlier style. (It's a lot faster to do than to explain.)

One of the things I like best about Ami Pro 3.0 is that it comes preconfigured with loads of useful items. There are 55 style sheets, with predefined styles for everything from business letters to faxes to newsletters. Graphics haven't been forgotten, either: There are over 100 pieces of predefined clip art that you can integrate into your documents. (You can, of course, import any graphical images.)

It would take thousands of words to cover all the features in Ami Pro 3.0. There are the usual bells and whistles you'd expect in a high-end package, such as automatic envelope and label printing, checking the grammar and spelling, and an elegant and easy-to-use mail merge. Unique features include SmartClick, which uses the often-ignored right mouse button for quick descriptions and quick changes. There's also Clean Screen, a nod toward WordPerfect users who like the minimum amount of distracting elements on the screen.

Last but not least, I have to mention SmartIcons, the customizable icon sets that are available in all of Lotus's Windows packages. The concept has been extended in Ami Pro 3.0 with seven sets of icons that you can mix, match, and edit to your heart's content. It's a useful way to make your work go faster and smoother.

Ami Pro 3.0 is a large program. Like Word for Windows 2.0, it requires about 15 MB of hard disk space. There's also a laptop installation option that loads the minimum features in 3.5 MB.

Choosing among high-end Windows word processors is not easy. The competing packages all have a core of similar features coupled with individual personalities. It's like choosing among a Ford, a Chevy, and perhaps a Toyota. At the bottom line, Ami Pro 3.0 sets a new standard that the competitors will rush to match.

—Stan Miastkowski

THE FACTS

Ami Pro 3.0
$495

Lotus Development Corp.
Word Processing Division
1000 Abernathy Rd. NE
Building 400, Suite 1700
Atlanta, GA 30328
(800) 831-9679
(404) 391-0011
fax: (404) 698-7653
Circle 1200 on Inquiry Card.

New Gigabyte Drive Is Portable but Pricey

The old bromide that "programs expand to occupy existing storage" still holds true. For MacFolk working with digital video, 24-bit-deep high-resolution scanned images, complex artwork, or color desktop publishing, the huge files created by these applications easily overwhelm hard drives that hold several hundred megabytes. Worse, in many cases you can't back up these files, even though you may need to transport them to a prepress house to create output.

Storage Dimensions offers an elegant solution. Its new **MacinStor MACB** transportable SCSI hard drives provide high-capacity storage of 235 MB, 500 MB, and 1 GB in a small, lightweight package. A 3½-inch SCSI drive, power supply, cooling fan, SCSI ID selector switch, and dual SCSI connectors are packed into a svelte 3¼- by 5¼- by 8-inch housing that tips the scales at 4½ pounds. The company uses a high-performance DEC SCSI drive that has a 10-millisecond seek time, a 512-KB read/write cache, and platters that spin at 5400 rpm to reduce latency.

A version of these drives (called 2Fast) implements a complete SCSI-2 interface that achieves data transfer rates of up to 10 MBps. Due to interface differences, the

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OPTIQUEST

"... Optiquest 2000D is the overall performance leader."
Byte Magazine: May 1992

OPTIQUEST
The Non-interlaced Company



2Fast drives won't work with the PowerBook.

I received a shipping version of the MacinStor 1-GB transportable drive (the MACB-1000F) for evaluation. The drive comes with a SCSI cable, a disk format and partition application, a Control Panel for mounting and working with disk partitions, two manuals, and a copy of Central Point Software's MacTools Deluxe disk utility software.

How do you test a disk drive? You make it do all the things you demand of a drive. I started by installing A/UX 3.0 from a Mac IIci onto the MACB-1000F. The drive's manual explains how to do this, but I let the A/UX Installer application handle the job because it now supports third-party drives. The process went without a hitch, and although Installer used a default A/UX partition size of 160 MB, A/UX ran perfectly.

Next, I reformatted the drive and used it as a shared volume on the IIci. I was able to set access rights without problems, and the drive immediately became the holding tank for huge scan files created by BYTE staff projects. The drive was then put into temporary duty as an AppleShare volume on our AppleShare file server. No problems were encountered here, either, because AppleShare 3.0 relies on much of System 7.0's features to function.

I finally connected the MACB-1000F to a PowerBook 170 with the appropriate SCSI cable and was able to use files on the drive. Because the drive runs off external power, you'll need to be near an outlet to use it this way.

The MacinStor's one fault is its $5059 price tag. Comparable 5¼-inch SCSI drives can be purchased for under $3000. However, its small size and weight make it attractive to graphics professionals who need to carry megabytes of drawings, images, or magazine pages to a prepress shop for output on a color typesetter. If transporting huge amounts of data is a big issue with you, the MacinStor 1-GB transportable drive is worth it.

—Tom Thompson

THE FACTS

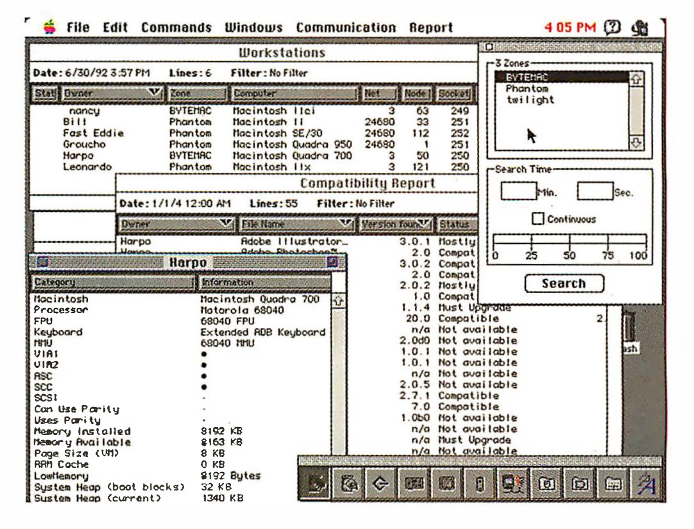
MacinStor
MACB-235F, $1679; MACB-500F, $3129; MACB-1000F, $5059

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1656 McCarthy Blvd.
Milpitas, CA 95035
(408) 954-0710
fax: (408) 944-1200
Circle 1201 on Inquiry Card.

NetOctopus 1.1 Manages Mac Network Resources and Software

Here's a network management product whose strange name accurately describes its function. **NetOctopus 1.1** is a network resource manager that lets a network administrator reach across an AppleTalk network (both LocalTalk and Ethernet) to manage the hardware and software resources of networked Macs. NetOctopus comprises a single management application and an InfoReporter Control Panel module that's installed on every Mac.

A network administrator uses the NetOctopus application to query a selected InfoReporter, which reports back the host Mac's hardware and software configuration. You can gather file information (e.g., names, creator, type, and version number) across the network and save it in a database for future reference. For example, you can query a zone of Macs about their CPU type, disk space, and memory to decide whether to install System 7.0 on your network and how much additional hardware you must budget for if you do.



New to version 1.1 of the software is support for System 7.0; a number of Apple events have been defined, so NetOctopus can be driven by other applications (e.g., UserLand Software's Frontier). NetOctopus now supports Apple Installer scripts. Thus, software like drivers or System software (e.g., Tune-Up) can be installed across the network. You can remotely change the Mac's printer selection, its owner name, or other user settings. NetOctopus is compatible with AppleTalk Remote Access, so a network administrator can manage company networks across the country.

Finally, you can perform software auditing with NetOctopus. You can specify

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Cambridge, MA 02138
617-661-1510
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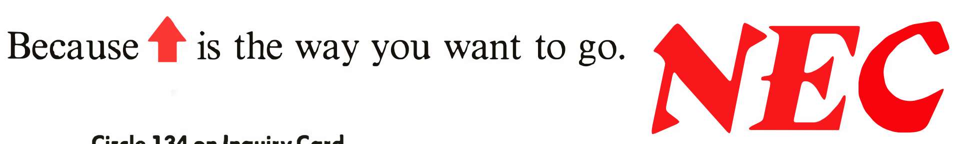


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how many legitimate copies of an application the company owns and let NetOctopus perform a tally of the actual copies present on the network. You can load a listing file that contains the names and number of copies of all the company's registered software before beginning an audit. If bogus copies are present, a network administrator can either delete the offending files (if this operation is allowed by the user's InfoReporter settings) or send the user a message to clean up his or her act.

I examined a beta release of NetOctopus 1.1 on BYTE's Mac network. This network is composed of both Ethernet and LocalTalk cabling, two bridges, and several zones. You scan a zone and then select a Mac to examine by clicking on its name in the Workstations window. Double-clicking on the Mac's name brings up a toolbar that lets you examine the system's hardware, System software, SCSI peripherals, NuBus boards, parameter RAM, and more.

The Apple script feature is a delight; I popped the System 7.0 Tune-Up 1.1.1 floppy disk into my Mac IIci, picked two new Macs on the network, and selected the Installer Scripts command. The floppy disk whirred and a log window appeared, informing me which files were removed or updated. I issued a remote Restart command to the two Macs, and the job was done.

Some of NetOctopus's file operations seem awkward; first you command a file search, and then you open a report window. The reason for this order of events is that you often scan numerous Macs simultaneously when gathering information for a software audit. Then you make a report from the collected data. This minor detail should be explained in Balloon Help, but it isn't. However, once you get the hang of this, NetOctopus becomes a capable tool for software inventory and control. Network administrators who must manage both the Macs and the software they run should check out NetOctopus.

—*Tom Thompson*

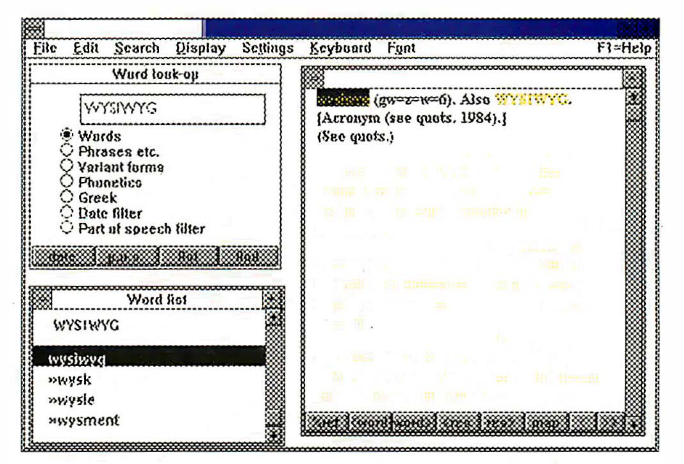
THE FACTS

NetOctopus 1.1
$645 for 10 users; site licenses available; free upgrade to version 1.0 owners

MacVonk USA
313 Iona Ave.
Narbeth, PA 19072
(215) 660-0606
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The Oxford English Dictionary Second Edition on CD-ROM

LONDON—The *Oxford English Dictionary* is the definitive reference guide to the English language. Unfortunately, the 20 huge volumes occupy over four feet of shelf space. Also, the set costs $3000. In 1987, Oxford University Press (OUP) released a CD-ROM version of the OED, but it was based on the 12-volume 1929 version. Thus, any words, quotes, or derivations that came after that date were not included. Nevertheless, BYTE found that version of the OED so useful that we presented it with a 1989 Award of Distinction (see the January 1990 BYTE).



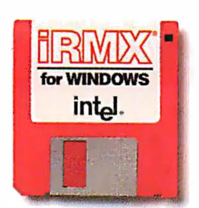
The **OED Second Edition on CD-ROM** runs under Windows and is based on the second edition of the paper-based OED that was launched in 1989. Having said that, the CD-ROM actually contains the most up-to-date information available on OUP's computer system, which in this case means late 1991. So the OED on CD-ROM is even more timely than the paper edition.

The OED is a treasure of information about the English language. The actual word you are considering is only a small part of the information provided. A single word (called the *head word*) will usually have a pronunciation, a part of speech, a list of variant forms, an etymology, a definition, a list of related head words, some phrases that use the word, and a vast number of quotations showing how the word has been used through the decades. This means that the entry for a single word can be very large. For example, the word *set* has a 750-KB entry that runs to some 60 pages in the paper edition.

Before you even install the software, I suggest you read *A User's Guide to the Oxford English Dictionary*, which explains in detail how each entry in the paper version is constructed. This short book is supplied with the OED on CD-ROM in addition to the CD itself and a software user's manual. A Macintosh version of the CD-ROM is expected in early 1993. The amount of data and indexes crammed on the disc is now close to the absolute maximum at 640 MB.

The beta version of the OED I tested still had no installation routine, and I simply copied the files from the floppy disk onto my hard disk. After loading Microsoft's CD extension, you load Windows and launch the OED application. You are presented with a blank window with the usual array of menu titles across the top. The most obvious place to start is with a search, which gives you five alternatives: word, text, etymology, definition, and quotation.

Selecting any of the searches presents a dialog box and a scrolling window containing all the entries for that data type in the dictionary. You can enter a word or phrase in the dialog box or jump to the scrolling window and interactively search the list by typing the first few letters of the word you want. I found the latter much more satisfying, because I could see when



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an entry wasn't listed rather than having the unhelpful "No entries found" message returned.

The results of any search are displayed as a scrolling list box, and you can select and view individual entries. There is a maximum of 8000 entries in a list box. If a search returns more than 8000 hits, it lists the first 8000 entries. You can paste search results into another Windows application or save them to disk.

There are some 600,000 individual references to words on the CD-ROM, but the most fascinating feature is the database of 2.5 million quotations. These quotations are included to show the usage of a particular word. The first quotation in any list can be considered the first published usage of the word. For example, looking up *WYSIWYG* reveals that BYTE has the first recorded usage of this acronym on page 264 of the April 1982 issue. What follows is a list of subsequent uses in magazines and newspapers.

The speed of a search is impressive when you consider the volume of data stored on the disk. Although timings are not final because this was a beta version, a search on the word *paper* returned 8157 entries in 12 seconds; a failed search takes just 3.5 seconds to report that no entries were found. Multiple word searches take longer. Because optimization is used, however, the least common word is searched for first, and subsequent words are searched only through the current hit list. For example, the phrase *Library of Congress* took 30 seconds to return a handful of entries, with *Congress* being used as the first search word.

Using the dictionary interactively is good for ad hoc queries, but for a serious language researcher, the process of accessing the information is just as important as the search results. Such users will want to take advantage of a query language that uses a SELECT statement to construct requests for information. The statements are easy to create, but for most people there is little point in doing this, because you can achieve most of what the query language does interactively.

My only reservation about this product is that it is addictive. While looking at it, I would quickly get sidetracked on an interesting reference. If you're self-disciplined, this isn't a problem. However, if you've got time on your hands, the OED on CD-ROM provides excellent entertainment. Now, did I mention that Jimi Hendrix and Pink Floyd get only one entry each in the dictionary? Well, actually this leads to...

—*Andy Redfern*

THE FACTS

Oxford English Dictionary Second Edition on CD-ROM
$850 (£495)

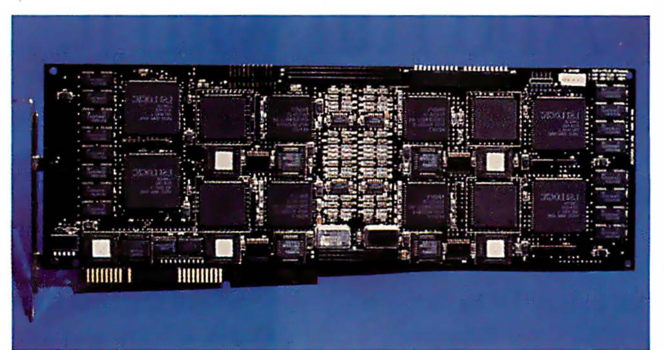
System requirements:
A 386 with 4 MB of RAM, Windows 3.0, and a CD-ROM drive with the Microsoft CD-ROM extension software (version 2.0 or higher).

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GammaFax MLCP-4/AEB: High-End Fax, Long-Range Potential

It's the latest in cutting-edge fax technology. Using your fax machine's phone, you dial a number and hear "Welcome to XYZ Company's fax information service. For information on widgets, press 1. For..." The automated system leads you through a menu and instructs you to press "start" on your fax or hangs up to call back your device.



Such services are not new. What is relatively new is GammaLink's **GammaFax MLCP-4/AEB** board. When coupled with a Dialogic multiline voice communications system, it lets systems integrators create voice/fax response applications for multiple-line, simultaneous access from a single PC slot. The MLCP-4 lists for $3995, but OEM volume discounts will be available.

The voice-synthesis board I used was Dialogic's $1150 Dialog/41D, which includes a DOS development kit. This board supports up to four channels for dial-up or—for heavy-demand services using an additional adapter like Dialogic's $2300 DTI/124—a digital T1 line. (Heavy fax broadcasting applications without voice synthesis require a direct connection from the MLCP-4 to the T1 board.) Dialogic also offers a 12-channel version, and multiple GammaLink and Dialogic boards can be installed in a single system for as many as 24 channels.

GammaLink was the first company to introduce fax hardware and software for the PC. It has now left behind the market's commodity-based low end to concentrate on high-end products like the MLCP-4. This product combines the features of the GammaFax CP network fax board with the AEB (Analog Expansion Bus) connection required for voice telephony.

Each fax channel on the MLCP-4 has its own dedicated 16-MHz 80C188 processor and 512 KB of DRAM, which eliminates the need to use interrupts or DMA. (All Dialog/41D boards that you install will share an interrupt.) The host system

Circle 200 on Inquiry Card.

recognizes the channels as I/O ports whose I/O-base addresses are set via four switches on the board.

The 16-bit board itself offers no direct telephone interface; rather, it relies on the separately sold voice-synthesis board (or a T1 adapter) to handle calls. A P3 20-pin ribbon cable connects the MLCP-4 with the voice-synthesis board through their respective AEB connectors, and you must give the cable a twist to properly align the pins. Beyond this, the MLCP-4's reference material and diagnostic programs (as well as those of the Dialogic board) prove sufficient to get the system up and running.

One necessary feature of the MLCP-4 is the CCITT Group 3 ECM (error-correction mode), which guarantees error-free fax transmission when the recipient's device supports it. If your application uses callback, however, your fax-connect time per call (and the resulting phone bill) will be even higher because of all the error correcting going on.

As with the standard GammaFax CP boards, you can use standard GammaFax applications like FAXM.EXE (the menu program) or the command-line GammaFax Command Language from DOS. You can run these from Windows 3.1 as well, and an OS/2 version should be available by the time you read this. But to develop applications where a board like Dialogic's will make fax requests to the MLCP-4—or for automated fax broadcasting—the $995 GammaFax Programmer's Interface is the ticket. Included as part of this DOS or OS/2 C-language GPI is a library whose four basic commands directly correspond with Dialogic's own API for control of the dispatcher, queue file, image handling, and real-time voice/fax processing.

GammaLink's GammaFax MLCP-4/AEB is a worthy entry into the market of shared and commercial fax applications, particularly in conjunction with a voice-synthesis board or a T1 board. Combined with the GPI, the potential for custom development is already putting a new spin on information retrieval. ■

—Ed Perratore

THE FACTS

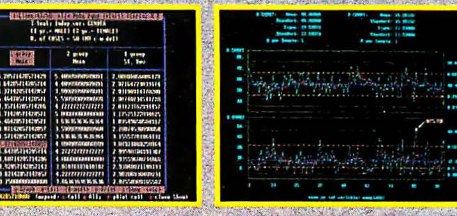
GammaFax MLCP-4/AEB
$3995 ($995 extra for GPI)

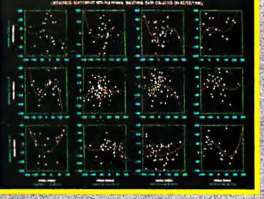
System requirements:
MS-DOS 3.3 or 5.0 (not 4.x), 640 KB of RAM, and 2.5 MB of free hard disk space.

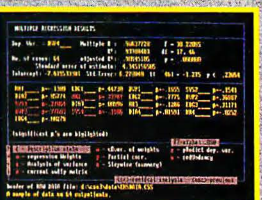
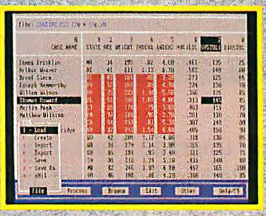
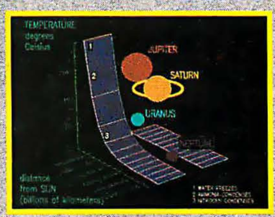
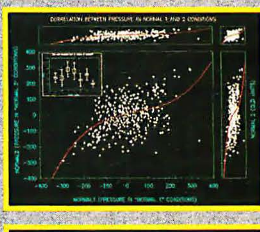
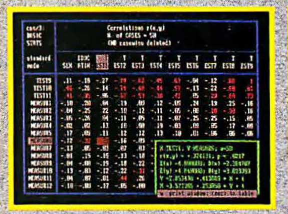
GammaLink
1314 Chesapeake Ter.
Sunnyvale, CA 94089
(408) 744-1400
fax: (408) 744-1900
Circle 1204 on Inquiry Card.

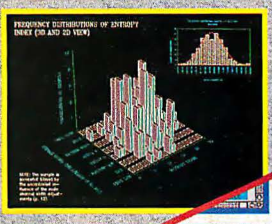
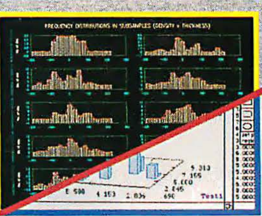
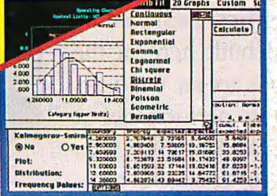
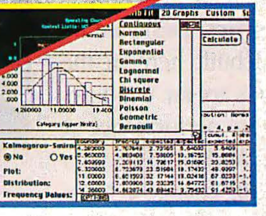
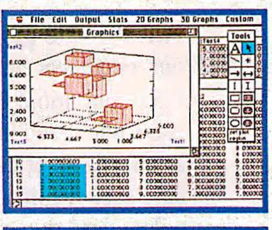
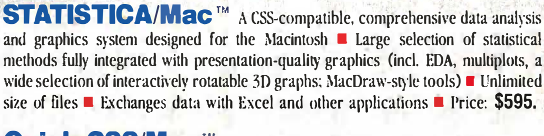
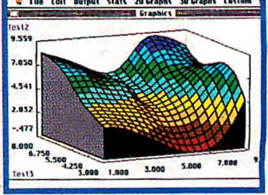
release 3.1 shipping

CSS:STATISTICA



CSS/3™ Complete Statistical System with over 1,000 presentation-quality graphs fully integrated with all procedures and on-screen graph customization ■ The largest selection of statistics in a single system; in-depth, comprehensive implementations of: *Exploratory techniques; multi-way tables with banners; nonparametrics; distribution fitting; multiple regression; general nonlinear estimation; logit/probit analysis; general ANCOVA/MANCOVA; stepwise discriminant analysis; log-linear analysis; factor analysis; cluster analysis; multidimensional scaling; canonical correlation; item analysis/reliability; survival analysis; time series modeling; forecasting; lags analysis; quality control; process analysis; experimental design (with Taguchi)*; and much more ■ Manuals with comprehensive introductions to each procedure and examples ■ Integrated Stats Advisor expert system ■ Extensive data management facilities (powerful spreadsheet with formulas; relational merge; data verification; flexible programming language) ■ Optimized (plain English menus/mouse) user interface: even complex analyses require just few self-explanatory selections (CSS can be run without manual; Quick Start booklet explains all basic conventions) ■ Macros, batch/commands also supported ■ All output displayed in Scrollsheets™ (dynamic tables with pop-up windows and instant graphs) ■ Extremely large analysis designs (e.g., correlation matrices up to 32,000x32,000) ■ Unlimited size of files; extended precision; unmatched speed (Assembler, C) ■ Exchanges data (and graphics) with many applications (incl. Excel®, Lotus 3®, dBASE IV®, SPSS®) ■ Highest resolution output on practically all printers (incl. HP, Postscript), plotters, recorders, typesetters ■ IBM compatibles, 640k or more ■ Price: **$595.**

Quick CSS™ Subset of CSS/3: all basic statistical modules (incl. data management) and the full, presentation-quality graphics capabilities of CSS/3 ■ Price: **$295.**

CSS:GRAPHICS™ A comprehensive graphics/charting system with data management ■ All graphics capabilities of CSS/3 and, in addition, extended on-screen drawing, 19 scalable fonts, special effects, icons, maps, multi-graphics management ■ Hundreds of types of graphs ■ Interactive rotation and interactive cross-sections of 3D graphs ■ Extensive selection of tools for graphical exploration of data; fitting; smoothing; spectral planes; overlaying; layered compressions; marked subsets ■ Unique multivariate (e.g., 4D) graphs ■ Facilities to custom-design new graphs and add them permanently to menu ■ Import/export of graphs and data, 15 formats ■ Optimized (menu/mouse) user interface; even complex graphs require few keystrokes: all graphs on this page can be produced from raw data in less than 20 minutes ■ Macros, batch/commands also supported ■ Unlimited size of files ■ Highest resolution output on all hardware (see CSS/3) ■ IBM compatibles, 640k or more ■ CSS:GRAPHICS is included in CSS:STATISTICA (available separately for **$495).**

Megafile Manager™ Comprehensive analytic data base management system ■ Unlimited size of files (up to 32,000 fields or 8 MB per record) ■ Megafile Manager is included in CSS/3 and CSS:STATISTICA (separately: **$295).**

CSS:STATISTICA™ A fully integrated system that combines all the capabilities of CSS/3 and CSS:GRAPHICS into a single extremely comprehensive data analysis system ■ Price: **$795.**

Domestic sh/h $7 per product; 14-day money back guarantee.

STATISTICA/Mac™ A CSS-compatible, comprehensive data analysis and graphics system designed for the Macintosh ■ Large selection of statistical methods fully integrated with presentation-quality graphics (incl. EDA, multiplots, a wide selection of interactively rotatable 3D graphs; MacDraw-style tools) ■ Unlimited size of files ■ Exchanges data with Excel and other applications ■ Price: **$595.**

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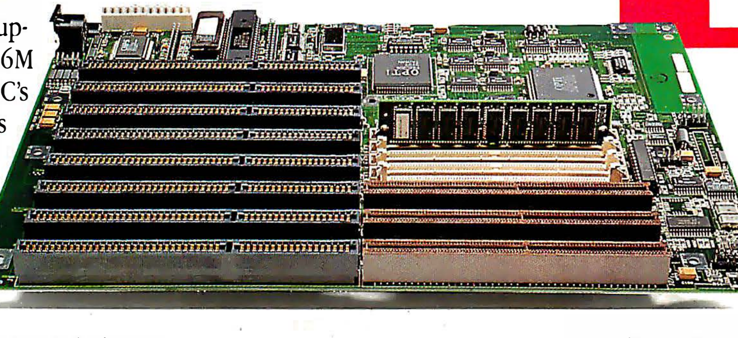
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Fax: (918) 583-4376

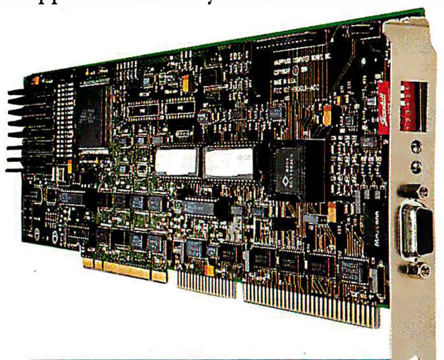
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Hauppauge announces an end

Modular Local Bus PC's from Hauppauge Computer Works

Bust the bottleneck. Hauppauge introduces its 486M series: Modular, LocalBus PC's designed for tomorrow's Windows applications ...yet affordable today. The 486M PC's bust the 8-MHz I/O bottleneck by using a local bus with a direct connection from the Intel 486 CPU chip to the graphics processor. There's also up to 1 MByte of CPU cache RAM and lots of system memory (from 4MB to 64MBytes). Features you can afford today. Features you'll appreciate in the years ahead.





Avoid future shock with Hauppauge CPU modules

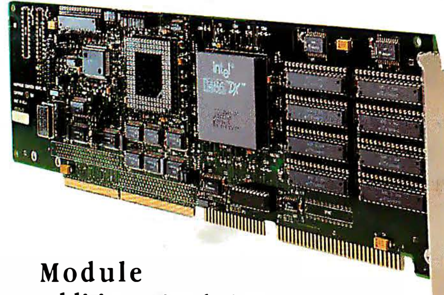
Full throttle graphics. Designed by our engineers and built here in the U.S.A., our 486M PC's are for Windows users who need more performance at an affordable price. And for users who have seen the dizzying change in technology and don't want to buy a new computer every two years. We know you don't want to replace your computer every time a new trend develops.

Fly non-stop. New generations of CPU's and software are being introduced at a rapid pace. Hauppauge's LocalBus PC's are designed to be upgraded in three ways: CPU upgrade, Module upgrade and Module addition:

The Modular LocalBus improves PC performance

CPU upgrade. Hauppauge 486M PC's are designed to accept any 486 CPU chip. Simply remove the old 486 from its LIF socket and replace it with a newer, faster CPU and you're off and running with the latest 486 processor power.

Module upgrade. As new generations of CPU chips come to market, CPU upgrade will not always be possible. The Hauppauge LocalBus is designed as a 64-bit bus to allow upgrades to future CPU generations with maximum performance.



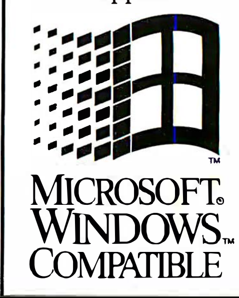
Module addition. Wondering what future software might require of your hardware? Our 486M PC's have a LocalBus slot for hardware accelerators that can solve long-term software problems.

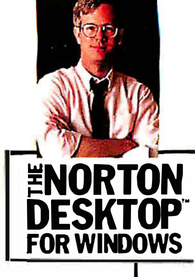
Local

Local bus graphics. For the absolute highest in Windows graphics performance, we've put our GUIacc (Graphical User Interface accelerator) right on the LocalBus. It includes the S3 graphics accelerator plus 1MByte of high speed Video RAM and a HiColor DAC. The GUIacc runs at the CPU speed, giving you the highest performance graphics combination available anywhere! Run your favorite true-color paint or drawing program with super performance.

All Hauppauge PC's include:

- Microsoft DOS 5.0
- Microsoft Windows 3.1
- Norton Desktop for Windows 2.0
- Factory installed, ready to run software on hard disk with floppy disk backups
- 30-day satisfaction guarantee
- One year warranty
- Unlimited technical support





Trademarks: Windows, DOS: Microsoft Corp.; Auto CAD: Autodesk; Intel Inside, i486: Intel Corp.; Norton Desktop: Symontec Corp.: 4860, Win TV, GUI acc: Hauppauge Computer Works; IBM PC: 28M Corp.; S3:S3 In.

to the Windows graphics jam:

Bus!!

33MHz 486M PC
$2595

Intel 486DX-33 CPU module
128K cache, expandable to 1MB
4MB RAM, expandable to 64MB
130MB <16msec cached IDE hard disk drive
Local bus GUIacc with 1MB VRAM and Hi-color DAC
14" Super VGA monitor
1.2MB, 1.44MB floppy disk drives
2 serial, 1 parallel
Maxiswitch 101 keyboard

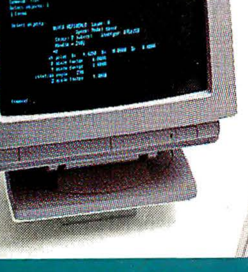


Intel 486SX-20 CPU module
128K cache, expandable to 1MB
4MB RAM, expandable to 64MB
130MB <16msec cached IDE hard disk drive
Local bus GUIacc with 1MB VRAM and Hi-color DAC
14" Super VGA monitor
1.2MB, 1.44MB floppy disk drives
2 serial, 1 parallel
Maxiswitch 101 keyboard



50MHz 486M PC
$2895

Full speed Intel 486DX-50 CPU module
128K cache, expandable to 1MB
4MB RAM, expandable to 64MB
130MB <16msec cached IDE hard disk drive
Local bus GUIacc with 1MB VRAM and Hi-color DAC
14" Super VGA monitor
1.2MB, 1.44MB floppy disk drives
2 serial, 1 parallel
Maxiswitch 101 keyboard



4860 CADstation

Our dual processor 4860 CADstation is designed for specific, heavy-duty AutoCAD applications. We've packed it with both a 33MHz 486 processor for fast overall performance and an Intel i860 RISC accelerator to speed up AutoCAD and Autoshade. And you'll get our 1152x900 24-bit per pixel local bus frame buffer for photo-realistic drawings. Dual monitor support plus the Hauppauge GUIacc top off feature list to make the 4860 CADstation the world's best PC for CAD!

Hauppauge's specially designed ADI/860 driver takes advantage of the i860 graphics capability for the best performance CAD system available. The ADI/860 is compatible with:

- AutoCAD rel. 11 and rel. 12
- Autoshade ver 2
- 3D-Studio version 1 and 2

Prices start at $6995.

Hauppauge!

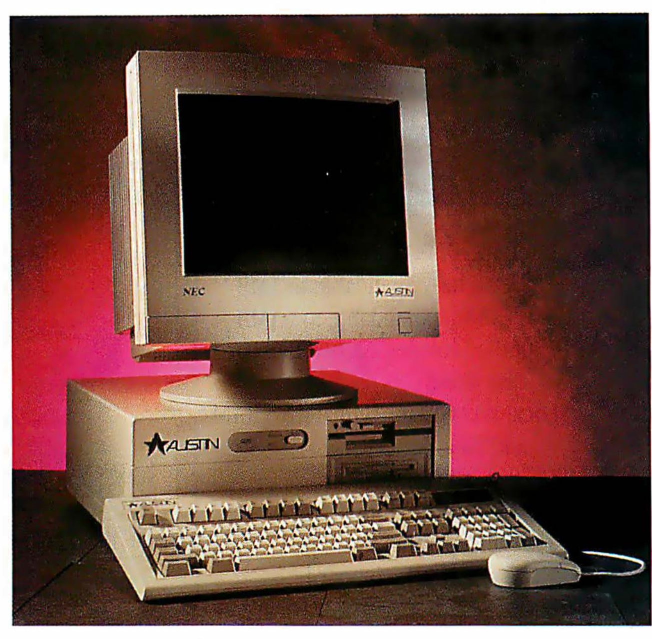
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Hauppauge, New York 11788-3706

800-443-6284
In New York: 516-434-1600
Fax: 516-434-3198

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An Integrated System

The Austin Executive Package includes an Austin 486/50 ISA system, a 210-MB hard drive, and 8 MB of RAM. It also has an NEC 4FG 15-inch noninterlaced flat-screen monitor, a Diamond Stealth VGA card with an S3 chip, and a Lexmark keyboard. The Austin Executive is preloaded with DOS 5.0 and Windows 3.1. An upgrade package for most Austin computers includes the monitor, the keyboard, and the VGA card.
Price: Austin Executive Package, $3890; upgrade package, $1290.
Contact: Austin Computer Systems, 10300 Metric Blvd., Austin, TX 78758, (512) 339-3500; fax (512) 454-1357.
Circle 1271 on Inquiry Card.

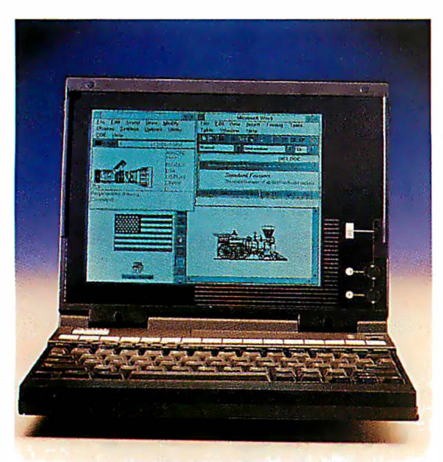


Austin Computer Systems' Executive Package integrates high-performance components for number-crunching and graphics applications.



Notebook Travels with 486 Power

The Model T50 486NoteBook, based on the 486-DX2 microprocessor, has 4 MB of RAM, 2.5 MB of which is 25-ns, 32-bit CMOS RAM. Total RAM is expandable to 10 MB. The 10-inch-diagonal, black-on-white, triple-supertwist VGA LCD has a resolution of 640 by 480 pixels with 16 gray scales. The Model T50 includes an 80- or 120-MB 2½-inch hard drive and an internal battery. The 5-pound notebook is 1⅛ inches thick. Options include a battery pack and an internal 2400-bps data/send fax modem. Standard software on the machine is DOS 5.0, LapLink Pro, and Battery Watch.
Price: With an 80-MB hard drive, $5599; with a 120-MB hard drive, $5899.
Contact: NoteBook Computer Co., 13100 Northwest Frwy., Suite 100, Houston, TX 77040, (713) 939-0486; fax (713) 939-1486.
Circle 1272 on Inquiry Card.



The 50-MHz Model T50 has an optional internal adapter for an external CRT monitor.

Ethernet for Everyone

A 386SX Ethernet workstation, the Lanco 320se runs at 20 MHz and has 2 MB of RAM (expandable to 8 MB). The unit includes an integrated 512-KB silicon RAM disk (expandable to 1.44 MB). Video consists of an ultra-VGA video interface that will support 1280- by 1024-pixel 16-color resolution or 1024- by 768-pixel 256-color resolution, and 512 KB of video RAM, expandable to 1 MB on the motherboard. The machine also has an analog and TTL monitor interface. All circuitry in the 6-pound machine is loaded on a single surface-mounted CPU board.

The 320se has Ethernet 10Base-2, 10Base-5, and 10Base-T connectivity; a bidirectional parallel printer port; and dual asynchronous serial I/O ports. Its user-selectable remote or local boot capability lets the network administrator make immediate system upgrades and control changes from the server. Software drivers are included for all disk or network operating systems.
Price: $1495.
Contact: Lanco, Inc., 800 West Airport Frwy., Suite 1100, Irving, TX 75062, (214) 438-4955; fax (214) 438-1571.
Circle 1273 on Inquiry Card.

Versatility at the High End

The full-size Dasher II-486/33LE EISA PC can be a NetWare LAN server or run Unix as a multiuser system. Connected to an Aviion server, the unit becomes a workstation; it also works as a single-user system.

Expandable to a 50-MHz unit via an exchange of motherboards, the system's basic configuration consists of a 33-MHz CPU, 4 MB of RAM (expandable to 28 MB via SIMMs and to 60 MB via a board), a 1.44-MB or 1.2-MB floppy drive, and a Super VGA card with 1 MB of video RAM that supports up to 1024- by 768-pixel resolution in 256 colors. The machine is designed to support Intel's 33-/66-MHz microprocessor when it becomes available.

The Dasher II-486/33LE includes five available 32-bit EISA bus-mastering slots and four half-height drive bays. You can configure three of the drive bays with a second floppy drive and as many as three hard drives, for a maximum of 1.5 GB of storage. The unit ships with DOS 5.0 and Windows 3.1. Optional 128-KB direct-mapped cache memory is available.
Price: $4095.
Contact: Data General Corp., 3400 Computer Dr., Westborough, MA 01590, (800) 328-2436 or (508) 366-8911.
Circle 1274 on Inquiry Card.

3 GB of Optical Storage

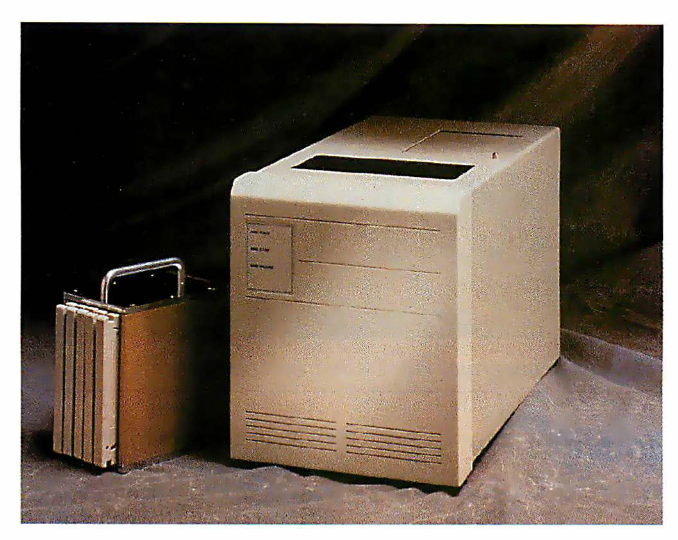
The HyperSpace Shuttle for SGI, based on the HyperSpace rewritable optical drive, is a plug-and-play desktop library for Silicon Graphics workstations. Able to handle up to five 600-MB cartridges in its magazine, the Shuttle's on-line storage capacity is 3 GB.

The 3600-rpm HyperSpace drive in the Shuttle has a 1-MBps sustained data transfer rate, an average access time of 37 ms, and an average seek time of 28 ms. The optical cartridges are compatible with other ISO-standard optical-drive products. The HyperSpace Shuttle is targeted at data-intensive graphics environments, such as CAD/CAM, animation, and imaging.

Price: $9990.

Contact: Ricoh File Products Division, Ricoh Corp., 3001 Orchard Pkwy., San Jose, CA 95134, (408) 432-8800; fax (408) 943-9364.

Circle 1275 on Inquiry Card.



The HyperSpace Shuttle for SGI allows data access across heterogeneous Unix networks.

PostScript Color Printing

Occupying less desk space than a laser printer, the Personal ColorPoint PS thermal printer offers a resolution of 300 dpi with 16.7 million colors. The printer lets you produce three- or four-color and monochrome images on paper or film.

The Personal ColorPoint PS provides full PostScript compatibility, supports HPGL (Hewlett-Packard Graphics Language) 7475A emulation, and provides 39-font Apple LaserWriter II emulation with bit-map smoothing.

Standard interfaces include serial, parallel, and AppleTalk. An optional video interface allows high-speed image capture, and you can store additional fonts on an external hard drive via an optional SCSI connector. The printer lets you increase the buffer memory size from the standard 6 MB to 22 MB.

The Personal ColorPoint PS also features linear Pantone color matching. Software drivers are included for Windows 3.0 and Mac OS environments.

Price: About $7622 (£3995).

Contact: Ambitron Ltd., 13 The Paddock, Hambridge Rd., Newbury, Berkshire RG15 5TQ, U.K., 44-635-36555; fax 44-635-32055.

Circle 1276 on Inquiry Card.

Projections in Color

ColorWorks LCD projection panels from Proxima use color-stripe filters with a passive-array LCD for high-quality color and light weight. The color-stripe filter technology, which permits all three color filters to be placed on one panel, enables the panels to project up to 24,389 colors with a contrast ratio of 20 to 1 and a resolution of 640 by 480 pixels.

With ColorWorks panels, you can add brilliant saturated color to charts, graphics, spreadsheets, and text. As a dynamic medium, ColorWorks lets you incorporate special effects and limited animation in your work.

The entry-level 9-inch-diagonal A502C and 11-inch-diagonal A522C ColorWorks panels are compatible with PCs, Macs, and Apple IIs. The panels have a full-duplex serial port and come with wireless remote control and cabling needed for high-impact VGA and Mac II presentations. The A522C includes presentation utility software and additional cabling. Both panels are compatible with Proxima's Cyclops interactive pointer system.

Price: A502C, $3995; A522C, $4995.

Contact: Proxima Corp., 6610 Nancy Ridge Dr., San Diego, CA 92121, (619) 457-5500; fax (619) 457-9647.

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The ColorWorks panel projects true color economically.

Portable Floptical Drive

FloptiPak 21, a 3½-inch 21-MB floptical drive, weighs less than 2 pounds for easy transportability. The SCSI device, which measures 1 by 9 by 5 inches, accesses its power through the floppy drive port of your Mac. The FloptiPak 21 uses optical servo track positioning and magnetic read/write technologies to achieve a density of 1245 tracks per inch. The drive reads and writes to standard 1.44-MB floppy disks for Macs and PCs and to 720-KB floppy disks for PCs.

Price: $699; media, $49.

Contact: Mass Microsystems, Inc., 810 West Maude Ave., Sunnyvale, CA 94086, (408) 522-1200; fax (408) 733-5499.

Circle 1278 on Inquiry Card.

Computer-to-TV Link

TV Link connects any VGA-equipped computer to a TV, TV monitor, or video projector. Able to display at resolutions of up to 640 by 480 pixels, the 3-pound unit has NTSC composite and S-Video outputs.

Price: $1165.

Contact: KDI Corp., 3975 McMann Rd., Cincinnati, OH 45245, (513) 943-2000.

Circle 1314 on Inquiry Card.

Desktop Video Publishing

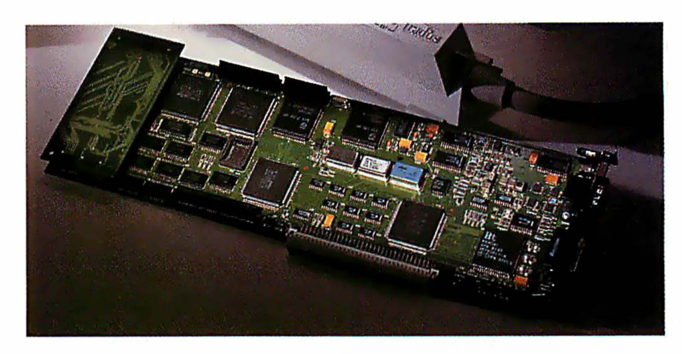
VideoVision brings video publishing to your desktop. The interface card contains built-in video input, video output, 24-bit graphics display capabilities, comprehensive software controls, and an external connector panel for video and audio connections. The integration of these capabilities lets you implement an idea in a number of different ways, such as in interactive on-screen demonstrations and as slides. The Mac-compatible card also allows you to input and output analog and digital video.

A built-in encoder provides flicker-free images directly to videotape and has on-board international-standards-conversion capabilities. Instantaneous variable window resizing without loss of resolution lets you display video at resolutions of up to 768 by 576 pixels. The card is bundled with Diva's VideoShop and MacroMedia's Action.

Price: $2399.

Contact: Radius, Inc., 1710 Fortune Dr., San Jose, CA 95131, (408) 434-1010; fax (408) 434-0770.

Circle 1279 on Inquiry Card.



VideoVision integrates video with sound and display.

Graphics Fly in True Color

Two boards follow different paths to fast graphics in true color.

A 32-bit graphics coprocessor board, Number Nine Computer's #9GXiTC supports the display of 16.7 million colors at resolutions as high as 1024 by 768 pixels. The board also creates a virtual workspace that supports 65,000 colors at resolutions of 1152 by 870 pixels and 1280 by 1024 pixels. In the virtual area, you can open multiple applications at the same time.

The card's HawkEye Feature Set offers unique capabilities. HawkEye Zoom lets you instantly magnify your entire screen by two, four, eight, or 16 times by pressing a hot key or a mouse button. HawkEye Chameleon Cursor lets you change the color of the cursor by clicking on an icon and selecting a color from a pop-up menu. HawkEye Resolution Exchange lets you click on an icon to select the desired resolution and number of colors you want to display; the Resolution Exchange changes the resolution, reboots your computer, and returns you to Windows.

Price: $2295.

Contact: Number Nine Computer Corp., 18 Hartwell Ave., Lexington, MA 02173, (617) 674-0009; fax (617) 674-2919.

Circle 1280 on Inquiry Card.

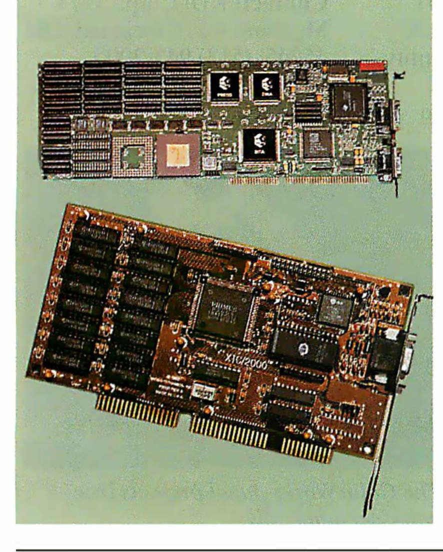
Video Dynamics' XTC/2000 24-bit graphics display adapter for PCs supports 2 MB of VRAM (video RAM), allowing displays of up to 256 colors at 1280- by 1024-pixel resolution. The board supports up to 65,536 colors at 800- by 600-pixel resolution, and up to 16.7 million colors at 640- by 480-pixel resolution.

The XTC/2000's hardware-accelerated graphics coprocessor speeds up critical graphics functions to more than 10 times the speed of standard Super VGA, according to Video Dynamics. Drivers on the board include support for AutoCAD, Windows 3.1, GEM, X Window System X11.5, Lotus 1-2-3, Ventura Publisher, and WordPerfect.

Price: With 1 MB of VRAM, $399; with 2 MB of VRAM, $499.

Contact: Video Dynamics, Inc., 1550 Bryant St., San Francisco, CA 94103, (800) 243-3527 or (415) 863-3023; fax (415) 863-2979.

Circle 1281 on Inquiry Card.



The #9GXiTC (top) and the XTC/2000 (bottom) offer two approaches to colorize high-resolution displays.

Upgradable CPU Cartridges

The i486DX/50 and 386DX/40 upgradable CPU cartridges from Positive can be used in any of Positive's CPU-upgradable systems. The 486DX/50 is based on the 486DX microprocessor for high speed and power. The 386DX/40 has a math coprocessor and a built-in RAM cache.

Price: 486DX/50, $1499.99; 386DX/40, $599.

Contact: Positive Corp., 405 Science Dr., Moorpark, CA 93021, (805) 523-0340.

Circle 1282 on Inquiry Card.

Boost Your IBM AT

Based on AT&T's DSP32C digital-signal-processing CPU, the DSP32C board provides your IBM AT with 25 MFLOPS of computing power. The board combines a 50-MHz version of the 32-bit DSP with 640 KB of 35-ns wait-state static RAM and a 32-bit bidirectional parallel port, which runs at full processor speed. The AT's bus can make memory transfers while the DSP32C is executing.

Price: About $2862 (£1500).

Contact: Neural Computer Sciences, Unit 3, Lulworth Business Centre, Nutwood Way, Totton, Southampton SO4 3WW, U.K., 44-703-667775; fax 44-703-663730.

Circle 1315 on Inquiry Card.

Try stuffing these into a laptop.

Laptops have their place, but for mission-critical applications requiring serious expansion, workstation power, CRT-quality screens or toolbox ruggedness, get a P.A.C.™ (Portable Add-In Computer). ■ **MASSIVE EXPANSION.** Nobody gives you more expansion possibilities then Dolch. In an 18 pound package a Dolch P.A.C. has room for up to five full-size EISA/ISA add-in cards. You can add up to 32 MB RAM, 1 GB HDD, and any combination of drives, CD-ROM, removable HD, streaming tape, and more. ■ **EXTREME POWER.** Dolch P.A.C. systems have been rated "the fastest portables on the market" since 1987, and have won more Editor's Choice awards then any other product in its category. *Computer Reseller News* calls the 486-50E "a dream machine . . . one of the most powerful PCs of any kind." P.A.C. systems are based on 386SX and DX, and 486 CPUs up to 50MHz, delivering as much as 22 MIPs. ■ **DAZZLING DISPLAYS.** "Breathtaking . . . Dolch's heart-stopping TFT Color Display produces vibrant colors and sharp images virtually on par with those seen on desktop VGA monitors," reports *PC Computing*. ■ **MIL RUGGEDNESS.** Every P.A.C. is as tough as it is powerful. Certified under MIL Std. 810C Dolch provides true mission critical reliability. ". . . it simply outclasses its competitors and it is sturdy and solid . . ." says *PC Magazine*. ■ **GET THE FULL STORY.** Call **1.800.538.7506**. In Canada 1.800.561.4527.





POWER PORTABLE ADD·VANTAGE

DOLCH COMPUTER SYSTEMS · 372 TURQUOISE STREET · MILPITAS · CALIFORNIA 95035 · USA

Circle 104 on Inquiry Card.

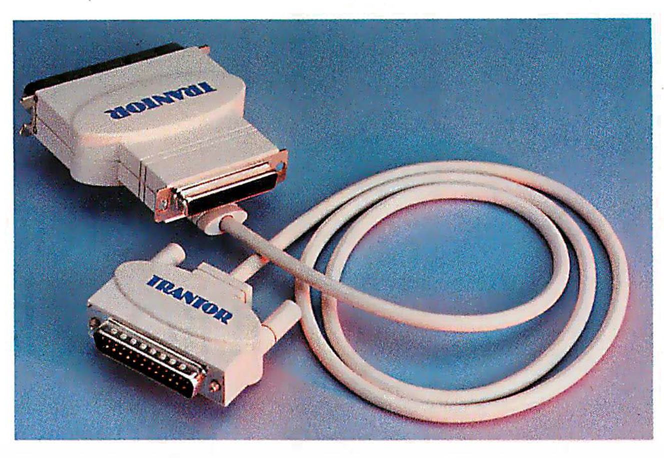
Bidirectional Data Mover

Designed around Trantor's P3C ASIC chip, the T348 MiniSCSI Plus parallel-to-SCSI host adapter enables you to move full 8-bit data blocks in both directions between the host computer and SCSI devices connected to the parallel port without losing the use of your printer. Transfer speed is similiar in both directions.

The portion of the adapter that contains the active circuitry is adjacent to the SCSI device, eliminating the need for a separate SCSI cable. The adapter is particularly suitable for use with CD-ROMs, according to Trantor.
Price: $229.
Contact: Trantor Systems, Ltd., 5415 Randall Place, Fremont, CA 94538, (510) 770-1400; fax (510) 770-9910.
Circle 1283 on Inquiry Card.

Sonic Digitizer

With the GP-10 Sonic Digitizer, you can digitize blueprints, drawings, maps, x-rays, film, and projected images without using a tablet. The single-piece unit lets you choose from eight output formats or program it for your own output; it has an on-screen menu for format selection via a one-time initialization. The digitizer is compatible with PCs and Macs, as well as with major software packages.
Price: $1775.
Contact: Science Accessories Corp., 200 Watson Blvd., Stratford, CT 06497, (203) 386-9978; fax (203) 381-9270.
Circle 1284 on Inquiry Card.



The MiniSCSI Plus connects CD-ROM and SCSI devices to laptops.

Keep Your CPU Cool

A commercial heat sink and miniature fan combination, the CPU Kooler complies with Intel's temperature specification for housing its 486 processors, providing an internal environment of from 32° to 185°F measured at the top center of the ceramic pin-grid array. Available in several heights to fit different cabinets, the CPU Kooler comes with a 12-V motor that connects to a floppy drive cable.
Price: $39.95.
Contact: PCubid Computer Technology, 6705 Silverthorne Cir., Sacramento, CA 95842, (916) 338-1338.
Circle 1285 on Inquiry Card.

Fast Printing

Kansai's high-speed printer buffers feature a DMA architecture on all I/O ports, achieving buffering throughput of up to 300 KBps. The EDB-30 (three ports), EDB-40 (four ports), and EDB-50 (five ports) buffers allow printers to receive data as fast as CPUs and bus architectures can transmit it. The buffers are available with 1, 2, 4, 8, or 12 MB of SIMM memory installed. You can daisy-chain multiple buffers, which don't require special software or drivers, the company says.
Price: $599 and up.
Contact: Kansai Electric USA, 2005 Hamilton Ave., Suite 220, San Jose, CA 95125, (800) 733-3374 or (408) 377-7062; fax (408) 377-7085.
Circle 1287 on Inquiry Card.

Virus Hunter

Version 2.0 of the PC Rx Antivirus uses a binary searching method that scans two to three times faster than the previous version in DOS and Windows to detect more than 1650 viruses. The program's pattern-independent TSR virus filter monitors suspicious programs for nine virus behaviors.

In Windows, PC Rx 2.0 lets you continue working while it scans in the background. This scanning reduces the PC Rx scanning meter to an on-screen icon, letting you view the progress. If PC Rx finds a virus, a scrollable Virus Found List pops up that gives you the option of clicking on one or a group of infected files and instructing the program to delete or rename the files or clean the virus.
Price: $69.
Contact: Trend Micro Devices, Inc., 2421 West 205th St., Suite D-100, Torrance, CA 90501, (800) 228-5651 or (310) 782-8190; fax (310) 328-5892.
Circle 1286 on Inquiry Card.

Power Protector

A computer and modem surge-protector strip, the EG556TC from Intermatic continuously monitors the incoming power line for a surge or spike. The unit responds within a nanosecond to absorb any overload while allowing normal voltage to continue to pass through the line. After the power returns to normal, the surge strip automatically resets to monitoring mode.
Price: $36.95.
Contact: Intermatic, Inc., Intermatic Plaza, Spring Grove, IL 60081, (815) 675-2321.
Circle 1317 on Inquiry Card.

Font Card for Okidata Printers

The TurboCard font card from UDP Data Products expands the usefulness of the Okidata 400/800 series of LED printers. The card provides Swiss and Dutch equivalent fonts, as well as the company's interpretation of typefaces such as Dom Casual, Copperplate, Old English, Brush, and Copper Black. Compatible with Windows 3.1, the TurboCard includes drivers for popular word processing packages.
Price: $249.
Contact: UDP Data Products, 2908 Oregon Court, Building I-2, Torrance, CA 90503, (800) 888-4413 or (310) 782-9800.
Circle 1316 on Inquiry Card.

There Are 174
In AutoCAD

3. Phenomenal 3D rendering. Capabilities that used to come only with AutoShade® are now built into AutoCAD® Release 12. And hidden line removal is up to 100 times faster.

4. AutoCAD SQL Extension (ASE) allows you to access data in standard database management systems via SQL. ASE provides commands for manipulating external nongraphic data and linking it to graphic entities in AutoCAD drawings.

5. Region Modeler creates intelligent 2D models. Allows you to quickly create 2D shapes with holes and complex boundaries. Automatically finds area, perimeter and inertial properties of a region.

6. Automatic timed save at user-selected intervals.

7. Now you can use PostScript® typefaces in AutoCAD drawings.

8. You can also import PostScript files into AutoCAD, and plot them.

9. New boundary polygon command surrounds an area with a closed polyline automatically.

10. New Fence or Polygon window crossing selection feature speeds selection of entities in dense and complex areas of drawings.

11. No Main Menu! You now enter directly into the AutoCAD drawing editor, where you can perform standard file handling and configuration operations, as well as work on your drawing.

12. Dramatically improved entity selection speed in large drawings.

13. Nested entity dimensioning. Entities within blocks or external references are now easily dimensioned.

14. Locked layers feature prevents accidental modification of drawing data.

15. PostScript output feature lets you enhance AutoCAD drawings by using PostScript-compatible imaging programs.

16. Release 12 and Release 11 drawings are forward and backward compatible.

17. Support for 255 individual pen widths for laser and electrostatic plotters.

18. You can plot without leaving the drawing editor. (And without losing the UNDO file.)

19. Now you can import TIFF, GIF and PCX raster images into your drawing.

20. GripEdit feature allows interactive editing of selected entities without running a command.

21. PickFirst feature lets you select entities prior to executing a command.

22. Improved external references. You can attach, reload or bind Xref files while the "master" is being edited.

23. Enhanced hatching. Automatically hatch bounded areas with a single pick.

24. New continuous polyline linetypes facilitate contour mapping and other applications.

25. Programmable dialog boxes can be customized for your particular working environment or by third-party application developers.

26. AutoCAD's new integrated calculator performs calculations based on existing geometry and includes extensive algebraic and geometric functions.

27. New ALIGN command lets you move and rotate entities in 2D or 3D.

28. 3D ROTATE command rotates entities about an arbitrary 3D axis.

29. 3D MIRROR command mirrors entities on an arbitrary 3D plane.

30. CHANGE command enhancements simplify entity property modifications, such as elevation, color, layer, linetype and thickness.

31. Advanced, multipoint tablet calibration allows compensation for map projections or stretched drawings.

32. Platform-independent menus and dialog boxes that follow operating system standards. So AutoCAD works like other programs on your computer.

33. An improved graphical interface makes the power of AutoCAD more accessible to everyone.

34. Cascading pull-down menus that put more power at your fingertips.

35. Pop-up menus at the cursor location for often-used items.

36. Screen menu is automatically updated to reflect the currently running command.

37. Shift and Control key combinations allow you to invoke more commands with your mouse and digitizer buttons.

38. Single mouse click-and-release action for selecting pull-down menus.

39. Automatic Drawing Conversion. Full support for any drawing created by any version of AutoCAD.

40. Enhanced CONFIG command allows for configuring AutoCAD from the drawing editor.

41. New dialog boxes give you control of dimension variables and styles.

42. Dimension dragging feature provides visual feedback while creating dimensions.

43. RECTANGLE command now allows you to create a rectangle with just two screen picks.

44. Enhanced Write Block command helps developers maintain "smart" drawings (entity handles).

45. Enhanced command transparency lets more commands be used inside other commands.

46. Transparent "Object Filters" dialog box allows more flexible definition of selection sets.

47. ZOOM Window is now the default.

48. DXFIX utility reads R12 DXF™ files and translates them into R10 files.

49. New COMPILE command compiles shape files, font files and Type 1 PostScript fonts.

50. Now you can fill closed polylines with PostScript patterns for extremely high-quality output.

51. Network users can view and plot AutoCAD drawings without using server authorization.

52. Database-specific drivers link AutoCAD and external nongraphic databases, such as dBase®, Paradox®, Oracle® and others.

53. Create New Drawing command now allows you to start with an unnamed

Now All Upgrades To AutoCAD Release 12 Are Only $500.

Offer Expires October 31, 1992.

Depending on what version of AutoCAD® you're using, the normal price of upgrading to new AutoCAD Release 12 could be as much as $3000. Act now and you can upgrade for only $500.*

☐ Yes, I want to upgrade now. Please have an Authorized AutoCAD Dealer call me.

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What platform? ☐ DOS ☐ Sun™ ☐ Other? ____________ Current Serial # ____________

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New Features Release 12.

drawing or specify a prototype drawing.

54. OPEN command presents "Open File" dialog box to simplify loading of existing drawings.

55. SAVE AS command now changes the current drawing name to new name specified.

56. END and QUIT commands prompt you for a file name when exiting an unnamed drawing, to prevent you from losing data.

57. Several AutoLISP® enhancements, including much faster loading of LISP routines.

58. A wide range of new and enhanced system variables, especially created for the power user.

59. DD Modify command allows for interactive editing of entity parameters.

60. New Units Control dialog box shows all units, angles and direction values on-screen as well as precision settings.

61. New special context-sensitive help dialog boxes allow you to browse through available help files.

62. New View Control dialog box allows selecting with a pick instead of typing in view name.

63. You can plot AutoCAD drawings as bit map files in PCF, TIFF, TGA and GIF formats. You can even automatically FAX your drawings to a subcontractor or client.

64. 24-bit, true color rendering is supported by appropriate hardware.

65. PostScript files can be brought in as outlines or fully rendered images.

66. Modify Entity dialog box enables you to edit an entity's properties directly.

67. Mirrored blocks can now be exploded.

68. List and load standard AutoCAD SHX fonts as well as Adobe Type 1 PostScript fonts from dialog box.

But Either One Of These Alone Makes It Worth The Price.

1. Something every AutoCAD® user has been waiting for: new technology that virtually eliminates regens. A new built-in 32-bit display list permits pans and zooms without regens. So you can spend your time editing your drawing, instead of waiting for regens.

2. The plot quickens. Now you get WYSIWYG plot preview, on-the-fly plot device selection and the ability to save plot configurations.



69. New option allows a box to be drawn around dimension text automatically.

70. Insert a text string before or after dimension text automatically.

71. Configuring for ADI® drivers has never been easier, with the new feature that displays all drivers in the appropriate menu when configuring AutoCAD.

72. HP LaserJet legal-size paper output is now supported by a new, improved device driver.

73. ADS applications can now be compiled by inexpensive "real mode" compilers; no need for costly development tools.

74. AutoLISP and ADS can now be used to drive the PLOT command.

75. Linetype scaling adjusts to view scale in Paper Space.

76–174. Unfortunately, we're out of space. But you get the idea. Release 12 is the most significant enhancement of AutoCAD ever. Its improved performance will pay off for every AutoCAD user. So the cost of an upgrade can pay for itself in a couple of weeks.

If you're still not convinced, call your Authorized AutoCAD Dealer. Your dealer can give you an even more complete list of the new features. And tell you what you need to do to upgrade. If you need more information or the number of your nearest dealer, call **1-800-964-6432, ext. 770.** Outside the U.S. and Canada fax 415-491-8303.



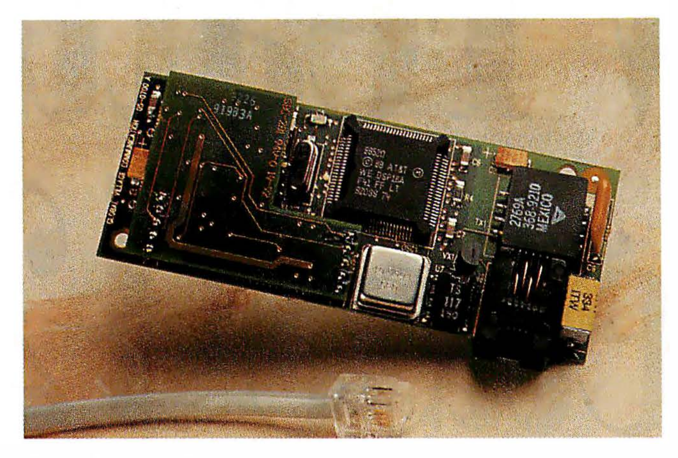
Circle 82 on Inquiry Card.

Internal Modems for the PowerBook

High-speed data access and faxing come to the PowerBook with Global Village Communication's PowerPort Gold internal fax/data modem. A V.32bis modem with V.42bis error correction and data compression, the PowerPort Gold provides error-free transmissions at a speed of 14,400 bps; faxes are transmitted at 9600 bps. The board also lets you connect transparently to AppleTalk networks at speeds simiiar to those of desktop access.

Also new are the PowerPort Silver and the PowerPort Bronze. Designed for moderate users of on-line services, the PowerPort Silver includes data access and has 9600-bps fax send and receive speeds. The PowerPort Bronze, geared for heavy users of fax services who sometimes need to communicate on-line, has 2400-bps data-access, 9600-bps fax-send, and 4800-bps fax-receive speeds.

Each modem works with any PowerBook. GlobalFax software wakes up a PowerBook to receive a fax and then returns it to sleep mode.
Price: PowerPort Gold, $795; PowerPort Silver, $595; PowerPort Bronze, $295.
Contact: Global Village Communication, 1204 O'Brien Dr., Menlo Park, CA 94025, (415) 329-0700; fax (415) 329-0767.
Circle 1288 on Inquiry Card.



PowerPort Gold makes location-independent computing a reality with your Mac PowerBook.

Integrate Voice, Fax, and Network Traffic

Micom Communications' remote Ethernet bridge, NetRunner, integrates voice, fax, and data traffic with LAN traffic over low-speed leased lines. With NetRunner, you can transmit synchronous and aysnchronous data, voice, and fax over the same line.

The company uses its Rapid Relay technology with NetRunner to squeeze voice and data traffic together with bridged LAN traffic. Data compression provides an average 100 percent increase in capacity of the leased-line bandwidth. Speech compression lets you combine speech with bridged LAN trafffic without slowing down the performance of your LAN.

NetRunner supports all LAN protocols and traffic. It has integrated modem and CSU/DSU (channel service unit/digital service unit) board options and built-in management functions. You can integrate up to six voice/fax channels with your LAN traffic.
Price: Starts at $3500.
Contact: Micom Communications Corp., 4100 Los Angeles Ave., Simi Valley, CA 93063, (805) 583-8600; fax (805) 583-1997.
Circle 1289 on Inquiry Card.



NetRunner integrates data, voice, and fax on leased lines.

Instant Serial Ports

QwikSwitch is a serial-port expander/data switch that increases the number of serial ports on your PC or laptop to five. You can direct data to any of five connected devices after you have selected the device from your keyboard. If you have a device that you use more frequently than others, QwikSwitch will default to that port.

With any-to-any port connections, QwikSwitch lets any PC access any other PC or device. A PC accelerator permits data transfer rates as high as 115,000 bps. The 1- by 4- by 7-inch unit connects to your PC's existing COM port.
Price: $175.
Contact: Western Telematic, Inc., 5 Sterling, Irvine, CA 92718, (800) 854-7226 or (714) 586-9950; fax (714) 583-9514.
Circle 1290 on Inquiry Card.

TSR Reboots Network Stations Automatically

A TSR program that brings back to life a NetWare network's print servers and gateways after a file server has crashed or been shut down, Lazarus periodically polls network integrity. When a network error or power outage occurs, Lazarus becomes active and continuously checks the network for activity. When the network is restored, the utility automatically reboots the stations on which it is installed and restores related services.
Price: Single copy, $74.99; server license, $299; site license, $2999.
Contact: Software Marketing Group, Inc., 108 Third St., Suite 202, Des Moines, IA 50309, (800) 395-0209 or (515) 284-0209; fax (515) 284-5147.
Circle 1291 on Inquiry Card.

LAN Snooper

The Snooper, a source code toolkit, helps developers build custom protocol analyzers for additional protocols used by applications software. Able to run on any PC, the analyzer captures live traffic on Ethernet networks. It then saves the captured packets for analysis through summary, hexadecimal, or decoded protocol displays.
Price: $350.
Contact: General Software, Inc., P.O. Box 2571, Redmond, WA 98073, (206) 391-4285; fax (206) 746-4655.
Circle 1318 on Inquiry Card.

Married. With children.

The traditional modem is a dying breed. And in its place comes a new generation of products.

Introducing the Intel family of faxmodems—a combination of our award-winning modem technology and SatisFAXtion® Board that brings you a no-compromise modem and fax in one. All for about the price of a data modem alone.

Our top-of-the-line product, the SatisFAXtion® Modem/400, is 50 percent faster than a traditional 9600bps modem. Plus it features unequalled fax capabilities. The Model 400e is the powerful external brother to the Model 400. And Models 200 and 100 are excellent values if you have less need for speed.

So don't settle for just a modem. For the ultimate performance, features and compatibility only Intel can give you, tie the faxmodem knot now.



Experience our no-obligation, 14-day Test Drive program. For the Intel Test Drive dealer nearest you, call 1-800-538-3373, ext. 63.



Circle 121 on Inquiry Card.

Many-Featured Modem

Patton Electronics' Model 1080 Universal Short Range Modem operates in synchronous and asynchronous RS-232 environments. The modem works over a 13-mile distance and at data rates of from 1200 to 19,200 bps. The unit supports point-to-point and multipoint communications.

The Model 1080 operates at full or half duplex over two unconditioned twisted-pair wires and at half duplex over a single pair of wires. Additional features include V.54 diagnostics, automatic equalization, transformer isolation, surge protection, and six front-panel LEDs.

Price: $295.

Contact: Patton Electronics Co., 7958 Cessna Ave., Gaithersburg, MD 20879, (301) 975-1000.

Circle 1292 on Inquiry Card.

A Fax Management System for Unix

Replix, a Unix-based fax management software system, lets you send, receive, route, view, and manage faxes from your desktop system. Incorporating an advanced GUI with a full feature set, Replix can be fully integrated with other software products and is based on a client/server architecture. The system automatically notifies you of incoming faxes and the status of outgoing faxes. It supports PostScript and is scalable, letting you add multiple clients, servers, and fax modems.

Price: $2395 and up.

Contact: Samsung Software America, 1 Corporate Dr., Andover, MA 01810, (800) 899-7724 or (508) 685-7200; fax (508) 685-4940.

Circle 1293 on Inquiry Card.



The Model 1080 Universal Short Range Modem operates at distances of up to 13 miles and can pass two hardware-control signals—one in each direction.

Version 3.0 Expands the Web

Version 3.0 of the Web network operating system consists of six loadable modules that you can install separately based on the individual requirements of each network station. You load each module into upper memory blocks, leaving intact the conventional memory area.

Web, which fully supports NetWare, replaces the NetWare client software on workstations, giving each station simultaneous status as a NetWare client and a Web peer. Web's emulation of NCP (NetWare's Core Protocol) enables the seamless sharing of files with an unlimited number of NetWare servers without a designated machine for bridging functions.

A new proprietary burst-mode technology in version 3.0 supports burst mode for up to 127 packets per transaction. The company's dynamic data compression increases data throughput by as much as 1400 percent in all topologies, according to Webcorp.

The system now supports large packet sizes of up to 16,384 bytes.

Able to freely mix peers, clients, and servers on the same network, Web 3.0 can also mix Web peers, clients, and servers with Novell servers. An independent setup program provides a single-user interface for local or remote modification of all station configuration and optimization options.

Price: Single-user, $99; 5-user, $449; 10-user, $765; 15-user, $975; 30-user, $1495.

Contact: Webcorp, 3000 Bridgeway, Sausalito, CA 94965, (415) 331-1449; fax (415) 331-0911.

Circle 1294 on Inquiry Card.

Standby UPS

A 600-VA UPS (uninterruptible power supply) with a built-in LAN port, the BC 600LAN is compatible with such diverse network operating systems as LANtastic and AppleShare. The unit features four spike and noise-filtered AC outlets.

Price: $377.

Contact: TrippLite, 500 North Orleans, Chicago, IL 60610, (312) 329-1777; fax (312) 644-6505.

Circle 1319 on Inquiry Card.

Cordless Serial Communications

Now you can communicate via serial interfaces without cables at distances ranging from 7 to 70 meters. The Infralink 818 provides an enhanced infrared transmitter/receiver unit that allows quick cableless data exchange between PCs and modems or between computers.

During serial operation, the device provides a net data transmission rate of 115,200 bps. The Infralink 818 uses full-duplex communication with invisible, modulated infrared light on eight switchable channels, enabling any number of PCs or peripherals to communicate with eight other units. Computer/printer recognition is always automatic.

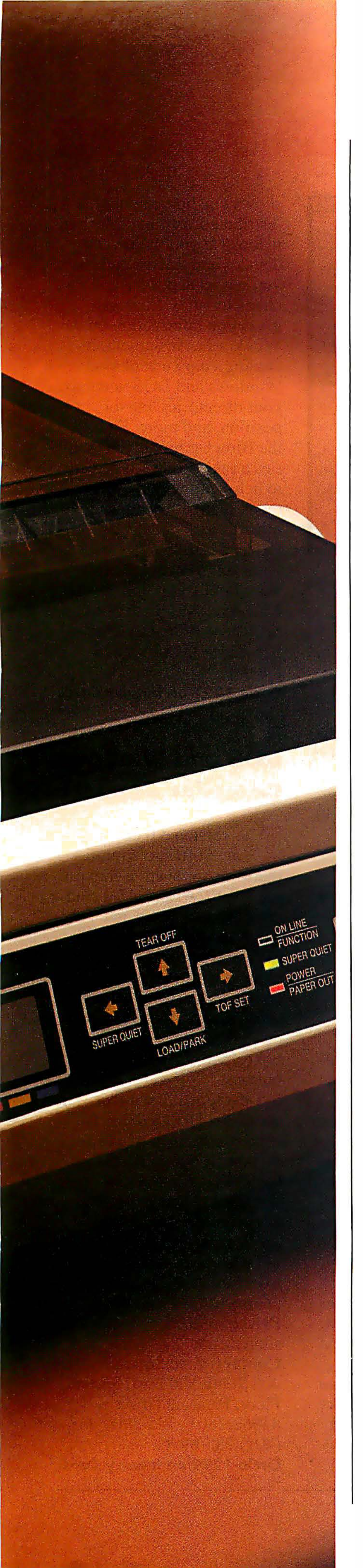
The unit displays the address and target address, as well as the status. An independent microprocessor-supported protocol assures data integrity, and the Infralink 818 uses a 9-bit identification code for error correction.

The Infralink 818 is available as an external unit or a built-in version that is suitable for laptops, notebooks, and notepads. Separate optical transmission/receiver unit accessories are also available for range optimization.

Price: About $299 (about DM 450).

Contact: Infralink GmbH, Am Fuchsberg 8, D-4040 Neuss-Uedescheim, Germany, 49-2101-3-50-53; fax 49-2101-3-27-91.

Circle 1295 on Inquiry Card.



A few dot-matrix printers offer you scalable fonts.

A few, color. But no other printer offers you scalable fonts...color...and Panasonic® Quiet Technology.

Put our KX-P2124 and 2123 to work and you'll get the flexibility of Adobe Type Manager® and scalable fonts...you'll add drama to your documents with our optional color kit...and you'll hear very little, indeed.

aA

ATM™

Put any of our other Quiet Technology printers to work and you can accomplish whatever your needs.

COLOR OPTION

From our 2123, a budget-minded 24-pin with Adobe Type Manager* and optional color...to our 2624 wide-carriage business printer with ATM*,...to our 9-pin 2180 with 6 near letter quality fonts and optional color.

All with the kind of features that made Panasonic printers the leaders of the industry. Such as multiple paper paths, EZ™ Set control panels, and a two-year limited warranty on parts and labor†.

The Panasonic 2000 Series Quiet Technology Printers.

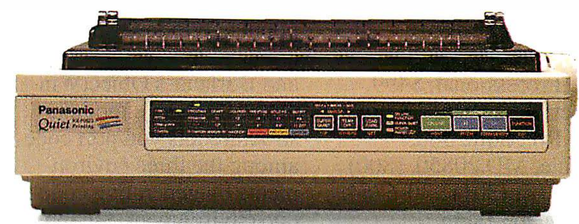
Call us for more information: 1-800-742-8086. Or visit your Panasonic dealer.

†See your dealer for warranty details.

*ATM and Adobe Type Manager are registered trademarks of Adobe. Adobe ATM for use with Microsoft® Windows™ 3.0 or higher. Available on selected printers only.



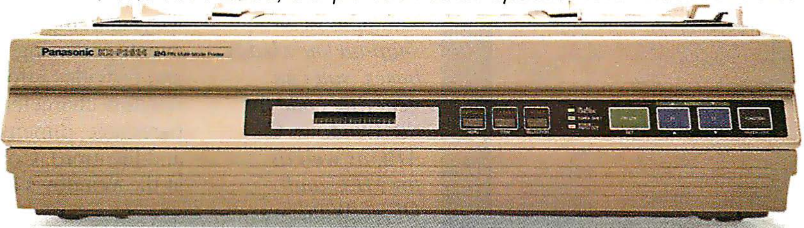
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PQ9-BY

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Customize Your Visual Basic Image Displays

The Dazzle/VB add-on control library for Visual Basic lets you customize your VB programs with a variety of graphics effects. Dazzle/VB's custom control and DLL routines let you display images in up to 256 colors, add more than 30 fade and wipe screen-transition effects, and adjust colors within your images.

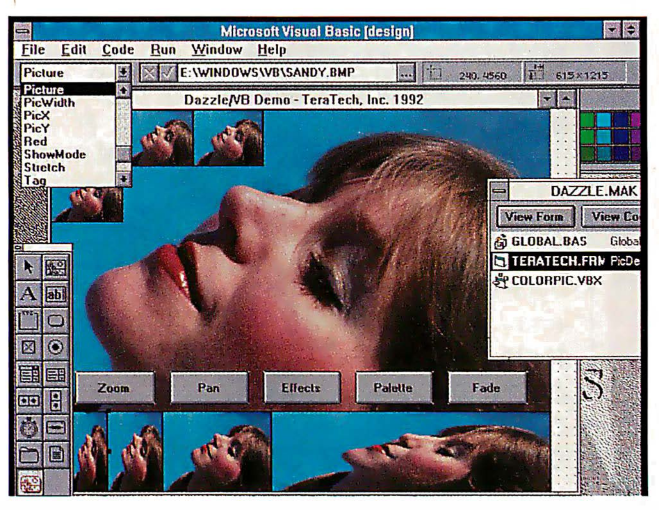
The Dazzle/VB DLL lets you use its partial image block copy routines to create your own wipe effects. To access and set Dazzle/VB properties, you simply click on the appropriate function, as listed on the VB properties menu, and it's set.

A more advanced version, Dazzle Professional, offers all the features of Dazzle/VB but adds tools for gray-scale and full-color negative image display, utilities to compress and decompress BMP files, color image enhancement, and palette control.

Price: Dazzle/VB, $299; Dazzle Professional, $499.

Contact: TeraTech, 3 Choke Cherry Rd., Suite 360, Rockville, MD 20850, (800) 447-9120 or (301) 330-6764; fax (301) 963-0436.

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TeraTech says that Dazzle/VB is the only true image controller currently available for Visual Basic.

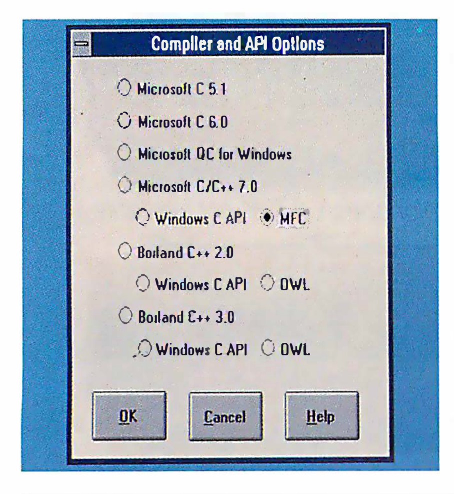
Generate Code for Windows APIs

Now you can automatically produce code for your MFC (Microsoft Foundation Class)–based Windows APIs. According to its developer, Case:W 4.0 is the only code generator for the MFC library for C/C++. The product also supports the other two most popular Windows interface builders, the Windows C API and Borland's ObjectWindows. Case:W's modular structure lets you port code among the three environments by generating code for one environment, "snapping on" a knowledge base of implementation details, and generating again to create the same interface in a different class library.

Price: Case:W with one knowledge base, $995; additional knowledge bases, $395 each.

Contact: Caseworks, Inc., 1 Dunwoody Park, Suite 130, Atlanta, GA 30338, (404) 399-6236; fax (404) 399-9516.

Circle 1298 on Inquiry Card.



With Caseworks' snap-on knowledge bases, you can generate code for the Windows C API, as well as for MFC and ObjectWindows class libraries.

Peek into Windows

DeMystifiers lets Windows programmers see how their applications interact with the internal components of the Windows operating system. Five independent tools capture information on memory management, message processing, graphic device interface display and device capabilities, systemwide environment settings, and screen image detail. The Voyeur component analyzes events occurring to windows and provides information on window characteristics (e.g., parentage, dimensions, class, and location). Colonel looks at the Windows kernel and shows you how memory is distributed within it. Mechanic looks at your hardware devices and drivers and lets you see related fonts and font characteristics. Ecologist gives you information on the Windows environment, including your current mode, Windows and DOS versions, your directories, cursor position, and more. Finally, the BlowUp module magnifies a region on your screen to help with window alignment, icon dithering, and other tasks.

Price: $129.

Contact: MicroQuill Software Publishing, Inc., 4900 25th Ave. NE, Suite 206, Seattle, WA 98105, (206) 525-8218; fax (206) 525-8309.

Circle 1297 on Inquiry Card.

DOS and Windows Compiler Support

The version 3.0 upgrade of Zinc Software's multiplatform application framework for C++ provides compiler independence and single-source compatibility to developers of DOS and Windows software. Zinc Interface Library 3.0 features push-button access to windows objects such as check boxes, scroll bars, and radio buttons.

Developed first under Windows, the DOS version features a Windows-like look with push-button access to tools. You can work in either text-to-graphics or graphics-to-text mode. The Zinc application framework provides support for Borland, Microsoft, and Symantec (Zortech) C++ compilers.

Price: $399.95; $499.95 with source code.

Contact: Zinc Software, Inc., 405 South 100 East, Second Floor, Pleasant Grove, UT 84062, (801) 785-8900; fax (801) 785-8996.

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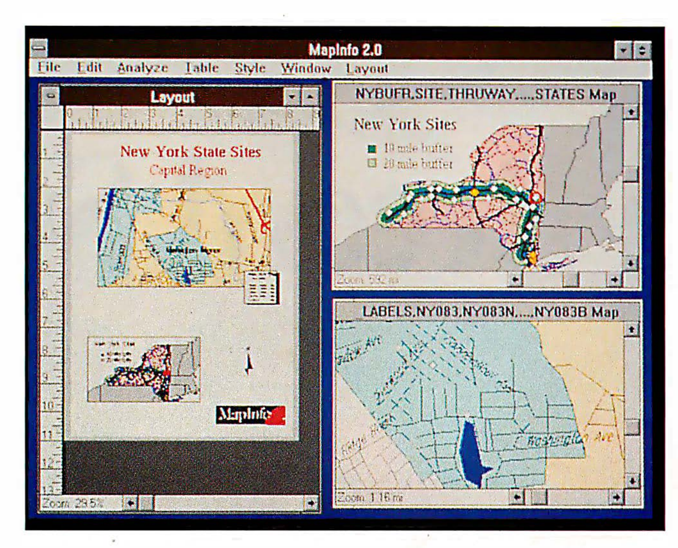
Build Your Own MapInfo Programs

MapInfo 2.0 for Windows uses a built-in SQL (Structured Query Language) relational database management system to let you access and display data geographically from databases, spreadsheets, and delimited ASCII files. You can overlap these data files to compare their contents. By displaying data such as a ZIP code or city name in relation to its location, you can see patterns, relationships, and trends that might otherwise go unnoticed.

New features include buffering, which lets you search around lines or areas by creating a specific border or corridor around them; support for object, line, and other query searches; SQL queries for "within," "contains," or "intersects" limits; 18 projection methods; and support for hundreds of coordinate systems. Enhanced presentation options include a page-layout window, improved graphics tools, and support for Windows 3.1 TrueType fonts and label text rotation.

MapBasic, designed for use with MapInfo 2.0 for Windows, lets you use a BASIC-like language to create your own MapInfo applications. Besides standard tools, such as an interface builder and program debugger, MapBasic lets you perform complex database queries using Standard SQL. You can also add graphical geographic objects to your maps, create buffers, and find perimeters and distances.

According to the company, all MapInfo files and applications developed in MapBasic are portable across Windows, Macintosh, Sun, and Hewlett-Packard platforms.



In MapInfo's upper right window, a buffer search around the New York State Thruway shows all the user-specified hits within a 20-mile drive.

Price: MapInfo 2.0 for Windows, $995; MapBasic, $795.
Contact: MapInfo Corp., 200 Broadway, Troy, NY 12180, (518) 274-6000; fax (518) 274-0510.
Circle 1300 on Inquiry Card.

Manage Complete Fills the Small-Business Bill

Manage Complete 2.0 for DOS offers a variety of business-oriented tools within a single program. At the heart of Manage lies a complete accounting program, geared toward small-business owners, that provides tools for accounts receivable, accounts payable, general ledger, checkbook, invoicing, sales order entry, bids and proposals, payroll, and inventory management. You can import data in 17 file formats. In addition to the accounting functions, Manage includes contact management, report writing, text editing, personnel files, applicant tracking, and other tools.

Manage is based on a FoxPro 2.0 database engine, which allows for real-time access to all your records. All Manage modules share a single set of data files, so you don't have to do updates across the system. Manage's network version shows you who is working on a record at any given time, and system administrators can limit access to certain tools.

Price: $299.95; $499.95 for unlimited nodes.
Contact: Management Information Software, Inc., 3301 Gandy Blvd., Tampa, FL 33611, (800) 825-5647 or (813) 832-3449; fax (813) 1311.
Circle 1301 on Inquiry Card.

ManagePro Takes Over Your Goals

MP (ManagePro) relies on a combination of scheduling, database, reporting, and expert system tools to provide goal management and people management tools in one program. MP for Windows outlines goals in a timeline format, displays your final goal as a composite of related tasks, and monitors the progress of those tasks.

The people-oriented tools in MP let you track and report on performance expectations and achievements, compensation, relationships between people and goals, and coaching of employees. The Management Advisor provides on-line access to professional advice. Password protection secures personnel data when you use the program over a network.

Price: $395.
Contact: Avantos Performance Systems, 5900 Hollis St., Suite C, Emeryville, CA 94608, (510) 654-4600; fax (510) 654-1276.
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Let Your PC Play the Stock Market

With AIQ TE (TradingExpert), your PC can track market indexes and equities and make trading recommendations. The program's expert system analysis of stock price, volume, and market indexes lets you monitor your picks using sector and group analysis, live trend lines, and weekly charting. TE makes recommendations based on updates of price and volume data. Its tracking capacity is limited only by your disk space, although AIQ Systems says that most users of the system monitor between 500 and 1500 equities.

TE users have the option of electronically accessing current and historical pricing on all equities for a monthly flat rate. Dial Data and Interactive Data provide this service to TE customers.

Price: $1499; on-line stock pricing data fee, $25 to $60 per month.
Contact: AIQ Systems, Inc., P.O. Box 7530, Incline Village, NV 89452, (800) 332-2999 or (702) 831-2999; fax (702) 831-6784.
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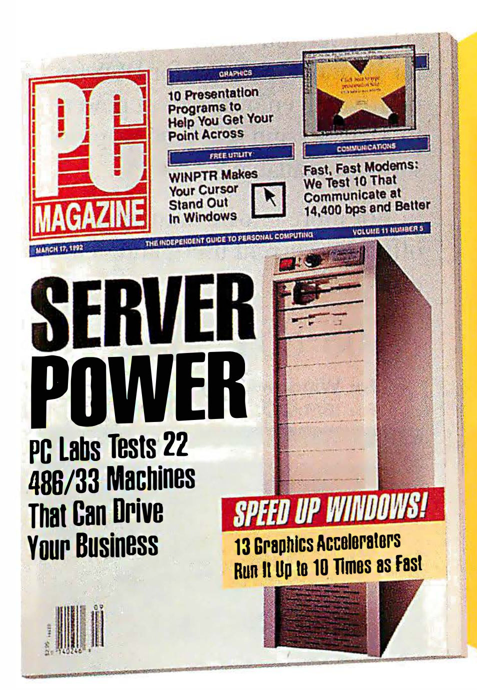
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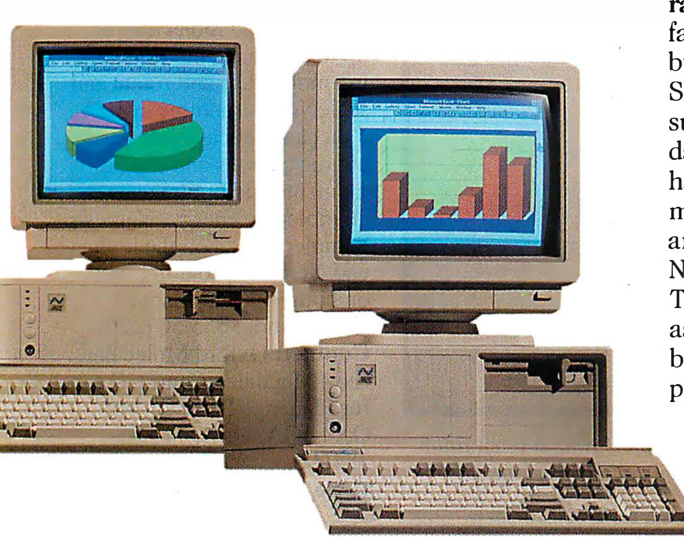
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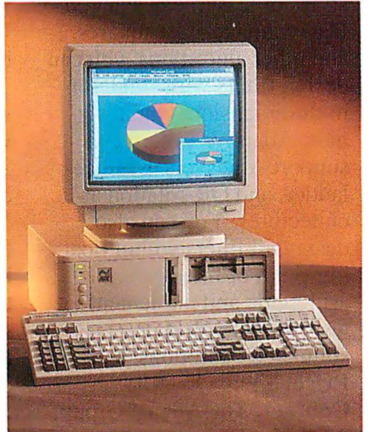
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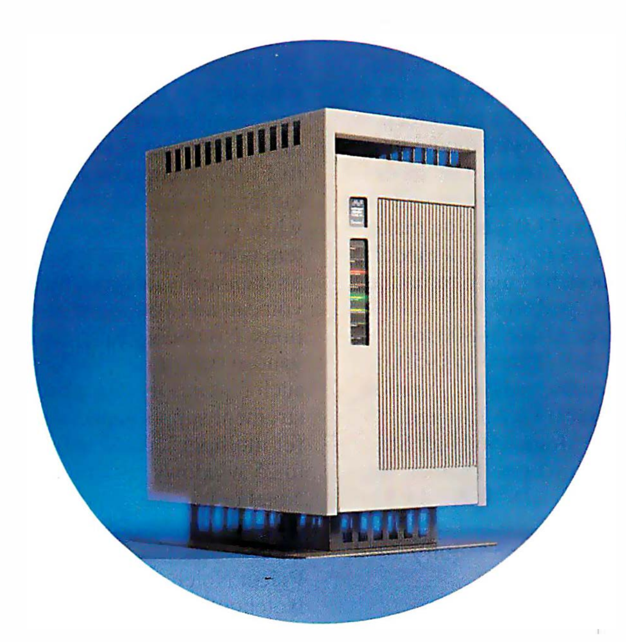


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A Scientific Swiss Army Knife Program

With the HiQ computational program for the Macintosh, you can create, solve, and present scientific and engineering problems in a single environment. HiQ's object-oriented architecture lets you manipulate your data with more than 600 built-in functions, interactive 2-D and 3-D graphics, and its own 4GL (fourth-generation language).

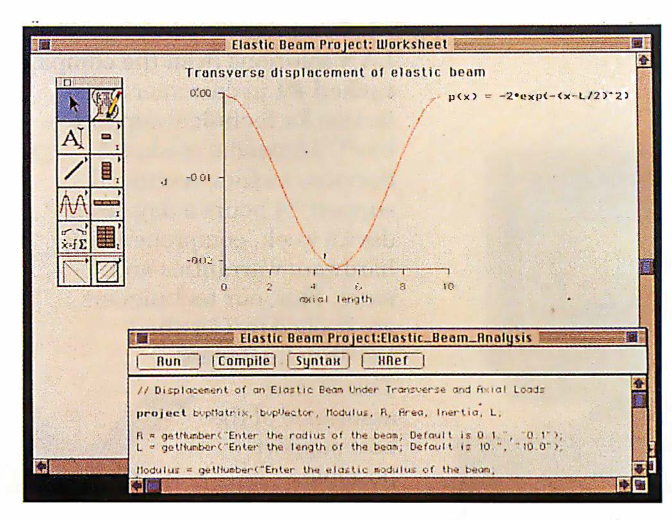
From within the system's mathematical solution interfaces, you enter functions, parameters, and other data. HiQ tabulates the results and plots the information as a 2-D or 3-D graph. As the system solves your equation, it simultaneously generates code written in its own programming language. You can use this code to create a larger, customized program for solving more sophisticated or specialized programs. Once you accumulate your desired graphs, notes, and other data, you can organize them into a single document.

According to its developer, HiQ lets users who specialize in different disciplines share tools and information without having to understand the intricacies of one another's work.

Price: $695.

Contact: Bimillennium Corp., 101 Albright Way, Los Gatos, CA 95030, (408) 866-2010; fax (408) 866-2305.

Circle 1304 on Inquiry Card.



HiQ's Project Worksheets let you group all your related data into a single document. From here you can click on an editor to change the Worksheet content.

Filter Program Tests DSP Data

Running under DOS, Adaptive Filters 2.5 lets you analyze your DSP (digital signal processor)–based data's adaptations as the data is affected by filter conditions that you create. Using several styles of least mean squared, fast recursive least squares, and other algorithms, you can design filters with single-or multidimensional input signals. Adaptive Filters supports transversal, lattice-ladder, and QR-rotation architectures. You can also design all filters within floating-point or fixed-point arithmetic and implement tests of real-world or simulated conditions.

Price: $399.

Contact: The Athena Group, 3424 Northwest 31st St., Gainesville, FL 32605, (800) 741-7440 or (904) 371-2567; fax (904) 373-5182.

Circle 1305 on Inquiry Card.

New Tools for Unix Element Analysis

The latest release of the LUSAS finite-element-analysis program combines new analysis elements with an updated menu- and form-driven interface. Unix-based LUSAS 11.0 runs under Motif and provides elements designed to examine linear and nonlinear stresses and vibration, and dynamic and thermal properties.

LUSAS uses an eight-node solid element, which its developer claims is faster than 20-node solid elements in the analysis of 3-D structures. New algorithms provide information on impact problems involving sliding friction between two or more surfaces, and a new creep facility lets you model time-dependent data. The superelement structure provided in version 11.0 lets you make changes to part of a model without having to rerun the entire problem.

Price: About $4800 to $18,240 (£2500 to £9500), depending on configuration.

Contact: FEA Limited, Forge House, 66 High St., Kingston upon Thames, Surrey KTI 1HN, U.K., 44-81-541-1999.

Circle 1306 on Inquiry Card.

Molecular Modeling for Novices

An introduction to molecular modeling is provided in a low-cost program from Oxford Molecular. Nemesis Sampler is an interactive modeling system that lets you build molecules of up to 50 atoms, modify existing molecules, and rotate and scale your structures in 3-D. You can also calculate partial atomic charges and dipole moments and optimize overall molecule energy. Nemesis Sampler, based on the high-end Nemesis program, runs on both PCs and Macs.

Price: About $55.50 (£29).

Contact: Oxford Molecular, Ltd., Magdalen Centre, Oxford Science Park, Oxford OX4 4GA, U.K., 44-865-784600.

Circle 1307 on Inquiry Card.

Windows Data Acquisition in Real Time

What its developer claims to be the first real-time data acquisition and display software for Windows is available now from Labtech. The Notebook and Notebook/XE programs let you collect data, display it in real time, and simultaneously log it to a disk at processing rates of up to 1 kHz. A configurable buffer lets you collect data while performing other system tasks. Notebook provides 58 data-analysis functions, or you can add your own functions. Notebook/XE's advanced functionality offers such features as remote instrument support and support for multiple screens with up to 25 windows per screen. Notebook requires Windows 3.1 and supports DLLs and DDE.

Price: Notebook, $1495; Notebook/XE, $2495.

Contact: Labtech, 400 Research Dr., Wilmington, MA 01887, (508) 657-5400; fax (508) 658-9972.

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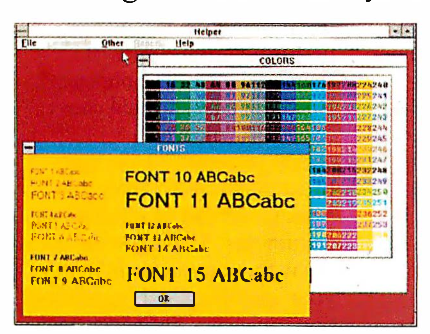
Attention All dBASE Users: Your Windows Have Arrived.



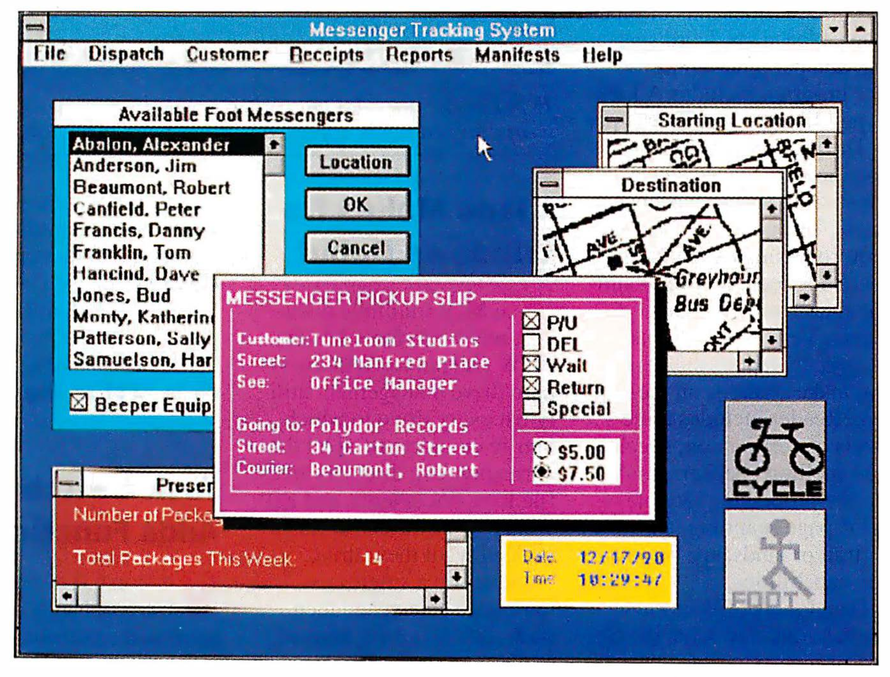
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NEWS

WHAT'S NEW • OTHER SOFTWARE

TypeReader Provides True OCR for the Mac

Using ExperVision's MLFA (Machine-Learned Fragment Analysis) technology, TypeReader for the Macintosh lets you scan clear, fuzzy, colored, and faded documents while retaining page-formatting characteristics. The software also recognizes thousands of typefaces, type sizes, word spacing, and paragraph returns. The program includes Adobe Type Manager and TrueType.

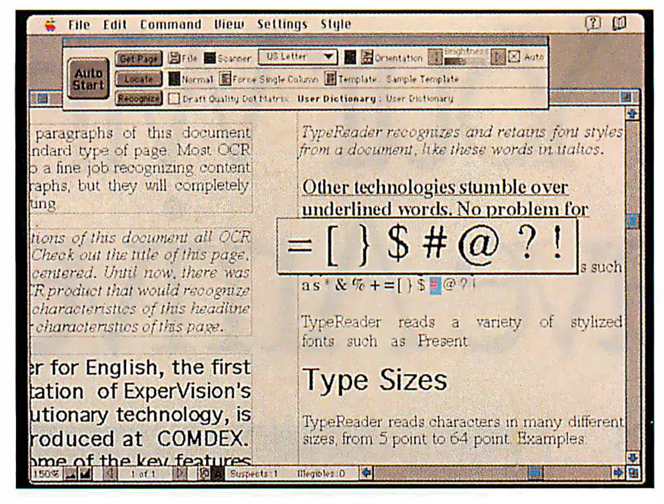
The program uses recognition dictionaries to reduce errors from suspicious characters. The context-sensitive postprocessing capabilities check for accurate use of similar characters. The On-Screen Verifier highlights suspect characters and lets you make changes on the fly. TypeReader includes three levels of verification, specialized spelling checkers, multiple file processing, double-sided-page scanning, and portrait or landscape orientation capabilities.

Developers of Windows applications now have the option of incorporating TypeReader's OCR capabilities into their own programs. RTK (for optical character recognition ToolKit) is available as a Windows DLL. The toolkit lets you specify what parts of an image to recognize when scanning. Your scanned data can then prompt such actions as message routing and updating a database. You can specify multiple areas to scan in each document.

Price: TypeReader, $695; RTK, $2500 recoverable licensing fee plus volume-based royalties.

Contact: ExperVision, Inc., 3590 North First St., San Jose, CA 95134, (800) 732-3897 or (408) 428-9988; fax (408) 456-0823.

Circle 1309 on Inquiry Card.



TypeReader provides mirrorlike recognition of margins, text wrapping, columns, tables, and other page formatting.

XTree Makes Its Windows Debut

An MDI (multiple document interface) lets the XTW (XTree for Windows) hard drive management utility list every drive to which you're connected and all the corresponding directory trees, file lists, documents, and ZIP archives. You can use XTW to display all these drive branches on a single customizable screen and then copy, delete, move, rename, and view files from this screen.

According to its developer, XTW offers more file viewers (over 50) than any comparable utility. In addition to viewing database, word processing, spreadsheet, and other files, the program lets you view ZIP-compressed files without extracting them. Other XTW features include application launching, a command toolbar, support for DOS-based networks, and background processing.

Price: $49.95 until the end of October, $99 thereafter.

Contact: XTree Co., 4330 Santa Fe Rd., San Luis Obispo, CA 93401, (805) 541-0604; fax (805) 541-8053.

Circle 1311 on Inquiry Card.

Task Switcher Adds Functionality

Version 6.0 of Software Carousel adds a screen saver and a personal reminder tool to the task-switching utility from SoftLogic Solutions. The DOS utility gives you hot-key access to up to 12 programs and lets you customize your task-switching methods.

Carousel's new personal reminder system lets you make note of time commitments (with or without an alarm) on a repeating or one-time basis. For an indefinite period of time, shipments of Carousel will include a copy of the Memory Miser 386 memory management utility.

Price: $89.95.

Contact: SoftLogic Solutions, Inc., 1 Perimeter Rd., Manchester, NH 03103, (800) 272-9900 or (603) 627-9900; fax (603) 627-9610.

Circle 1312 on Inquiry Card.

ZyIndex Gears Up for Windows

ZyIndex 5.0 for Windows encompasses several modules, which offer index-building, index-searching, and application-building capabilities. The index builder, ZyBuild, lets you create an index of documents that reside anywhere on your hard drive or network.

New searching techniques and tools include display of search hits in context, logging of searches, application launching, simultaneous searching of multiple indexes, a viewer for embedded graphics files, support for dBase files and other database file formats, document archiving, and support for Windows 3.1. You can perform various types of searches, including phrase, Boolean, user-defined concept, and wild-card.

The program's InfoApps function lets you create and manage groups of related documents. These groups act as customization tools for your searching and organization processes. InfoApps let you add hyperlinks, annotated self-stick notes, bookmarks, compression, and other features.

Price: $395 for a single-user version; $995 for a network bundle of three concurrent licenses.

Contact: ZyLab, 100 Lexington Dr., Buffalo Grove, IL 60089, (800) 544-6339 or (708) 459-8000; fax (708) 459-8054.

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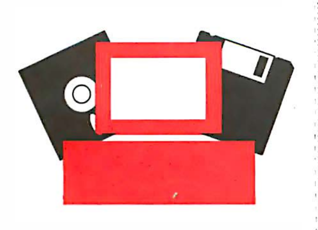
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- 2 ❑ Programmer/Systems Analyst
- 3 ❑ Adminstration/Management
- 4 ❑ Sales/Marketing
- 5 ❑ Engineer/Scientist
- 6 ❑ Other

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- 7 ❑ Senior-level
- 9 ❑ Professional
- 8 ❑ Middle-level

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- 11 ❑ No

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- 15 ❑ Unix
- 13 ❑ DOS+Windows
- 16 ❑ MacOS
- 14 ❑ OS/2
- 17 ❑ VAX/VMS

E. For how many people do you influence the purchase of hardware or software?
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- 20 ❑ 51-99
- 19 ❑ 26-50
- 21 ❑ 100 or more

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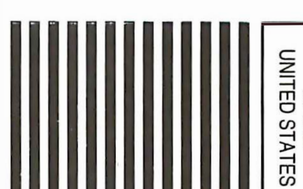
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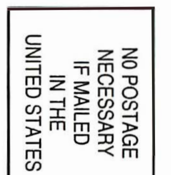
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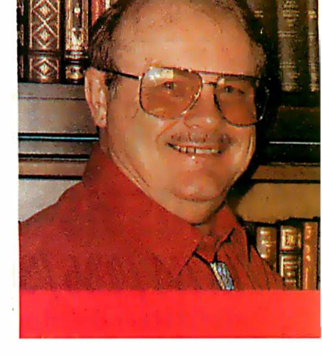
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JERRY POURNELLE

THE AMIGA REVISITED

I suppose I could start by saying it has been another hectic month, but then every month seems to warrant that. Of course, this is Chaos Manor.

I had hoped to get to OS/2 this month. It's not all my fault. OS/2 installs only from the A drive. Like most real-world systems, my machines take a 5¼-inch disk on the A drive and a 3½-inch disk on the B drive. For months IBM never sent me any copy of OS/2; now I have no fewer than 14 copies—and every single one is for 3½-inch drives. Now the solution is to open the Gateway 2000 486/50, swap cables for the drives, run Setup, and inform the computer of the change.

Alas, about the time I was ready to swap cables, I heard new rumors that IBM is coming out with a bug-fixed version of OS/2. I've got enough reports of known bugs that it makes sense to wait. In fairness: I also have reports from highly enthusiastic readers who say that OS/2 runs many DOS sessions in true multitasking; that it runs most important Windows applications flawlessly; that it was easy to set up, and there wasn't any messing about with a PIF (program information file) and the like; and that they have had few to no problems.

Anyway, next month, OS/2 for sure. IBM says they have a fix that lets you install OS/2 from the B drive, and they're sending that as well as 5¼-inch disks.

Laptops

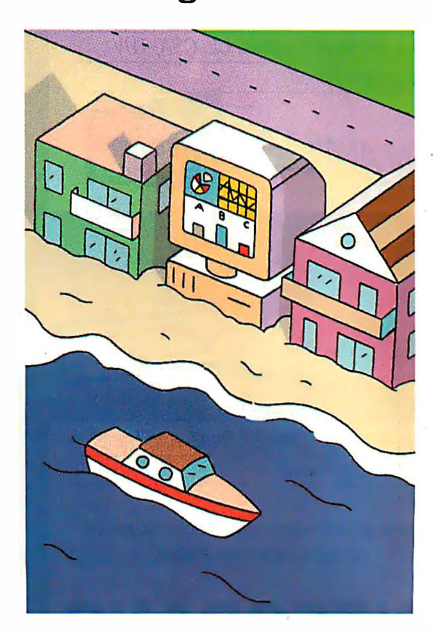
We went down to the beach house this month. The theory is that Larry Niven and I can pop down there away from the phone and do fiction without distractions. That works surprisingly well. Roberta and I also go there when I'm working on my own books; and, of course, it's an excellent place to experiment with concepts of computer portability. This time I may have gone a bit far.

I had with me Moby Brick, which is a 486 computer smaller than a box of Microsoft Windows software; an older 386 Brick; the ancient Zenith Supersport SX; the new Zenith Mastersport; an older Texas Instruments TravelMate 3000 WinSX; a Gateway notebook, the Nomad 420SXL, which appears to be identical to the WinSX except that it has a Gateway label and 2 MB less memory; the newest AT&T/NCR Safari; and probably a couple of others I lost track of. We had enough computing power to run the city of San Diego. I also had bags and bags of software. Our beach house looked like an electronics shop.

I hadn't really lost my mind. Much of my on-the-road software was scattered across several computers, and I hadn't had time to consolidate it preparatory to passing a couple of those machines along to local schools. There was also a lot of uninstalled software. I got all that straightened out and took the opportunity to do a bit of comparison.

Ergo Computing's Moby Brick has been my main machine when I'm at the beach, and it still is. It's not something to carry on the road: we're about to take off for San Francisco and Silicon Valley, and I won't take it along. The advantage of Moby Brick is that when I get it connected up to a good color monitor, keyboard, and mouse, I can't really tell the difference between it and my main machine; or I couldn't until recently, anyway. I keep a power supply, a Microsoft "Dove bar" mouse, and a Northgate OmniKey Plus "Pournelle-configuration" keyboard at the beach house, so all I have to carry back and forth is Moby Brick itself.

Jerry looks at transportable and notebook computers and takes a closer look at the Amiga 3000T



Ergo furnishes a heavy-duty padded case for transporting Moby Brick, but I confess I don't bother. My Moby Brick resides in an old Wingz shoulder bag, and there's room in there for the computer, telephone cables, a notebook, a pile of floppy disks, and some pencils. Obviously I don't throw it across the room, but I'm not all that careful with it; and so far it has survived many trips, as has its predecessor, the 386 Brick.

I also keep a "Niven-configuration" keyboard: my partner for some unaccountable reason likes old AT-style keyboards with the function keys across the top, and the Control key down by the Shift key, where Satan wants it. Having both keyboards makes it easy to set Moby Brick up for Larry.

Larry's not yet into Windows, so he gets a setup that, except for the smaller 15-inch Princeton monitor (as opposed to the 20-inch Nanao Flexscan he favors), is identical to his home operating environment, which is

ILLUSTRATION: STEVE TURK © 1992

Desqview. That's what I used until recently.

The first thing I did when I got things set up at the beach house was to install Windows 3.1, updating the previous Windows 3.0 installation that came with Moby Brick. That worked just fine. However, when I tried to convert the screen from 640 by 480 pixels to my usual 1024 by 768 pixels, I couldn't do it. I suspect I don't have the right drivers for Windows 3.1. I'm not complaining: on a 15-inch screen, 640 by 480 pixels is actually good enough. It's all I get on a laptop, and indeed about half the Windows-using computers in Chaos Manor are set to 640 by 480 pixels.

On the other hand, I didn't have much problem with a CD-ROM device for Moby Brick. I used one of the little Trantor devices that converts your printer port to a SCSI port, and it worked OK. Actually, I did that only for a test, but now that Microsoft has integrated Word for Windows and Bookshelf—more on that later—I'll want CD-ROM capability on trips as well as at home.

One of the main advantages of Moby Brick over a laptop is its single half-card slot, which can hold, say, a SCSI controller or a Sound Blaster; but technology is catching up here. Not only does Trantor have a parallel port–to–SCSI device, but Zircom has an Ethernet connector that can hook your portable into your main system. Most laptops have VGA output, so if you have a monitor, you can get color.

Supra has a neat little 14,400-bps fax modem, so you don't need a fax card on the road. The Supra modem also has error-correcting capabilities, which will let you work through noisy hotel phone-line systems that overwhelm the built-in modem in most laptops. The Supra modem is small enough to stuff into the computer carrying case if you're not checking luggage. Of course, it does use a serial port, so if your portable doesn't have a second serial port or separate mouse port, you can't use a mouse and an external modem at the same time.

Moby Brick remains an excellent tool for going from one fixed location to another; but I'd hate to have to carry the monitor and keyboards along on every trip. What with new tiny hard drives, small high-capacity external hard drives, and new improvements in chip technology, laptops are catching up with portables in capability.

Laptop Wars

When we went up to San Francisco, we winnowed things down to two laptops. One was my Mastersport. I love Zenith laptops. Last week we had to repair the ancient Z-183 laptop I gave our church. It cost $83.50, the first repair it has needed in five years of hard use.

Roberta chose the Nomad 420SXL. It's preferable to TI's WinSX even though it has less memory, because the WinSX has taken lately to locking up at unexpected intervals. It does that only when it's doing a big modem download, so there's screen action but no keyboard activity. We don't know if the problem is connected to the WinSX's screen blanker/disk drive manager software, or if there's a heat problem, or if a chip got loose. Otherwise, the machine works just fine, and while we're off up north, I'll have Alex take it to a good repair shop. The main point here is that Roberta, having had a chance at half a dozen laptops, is very fond of the WinSX, and since the Nomad is identical to it except for memory, she's quite happy to take the Nomad.

Gateway furnishes better documentation with their machine than TI did. The external power pack is much smaller and puts out a lot less heat. The Nomad comes with different memory configurations. The documentation says that installing more memory is tedious and requires removing the keyboard. I think the machine needs the full 4 MB—Windows machines really do need a lot of memory—so if you're not mechanically inclined, your best bet is to get one with the full 4 MB in the first place.

The Nomad comes with the same "sort of mouse" that came with the WinSX. It's a tiny little thumb-ball device, and it's no good; at least I can't use it well. Fortunately, we have a Logitech TrackMan Portable. That's so neat you may want to use it on your desktop machine, and it works just fine on the Nomad. The Nomad comes with Windows 3.1 installed. I'm not happy with the Microsoft memory managers, so I installed QEMM-386, as I routinely do with new machines.

Like Niven, Roberta is still using Desqview rather than Windows, and QEMM-386 works with both. You do want to boot without the DOS=HIGH statement in CONFIG.SYS if you're running Desqview, and you may want some other customizations. The easy way to do this is to have a couple of batch files: MAKEWIN.BAT copies CONFIG.WIN and AUTOEXEC.WIN to be CONFIG.SYS and AUTOEXEC.BAT; MAKEDV.BAT does the same for CONFIG.DV and AUTOEXEC.DV.

Help!

One other thing the WinSX had was an on-line menuing system and help file manager called Lap Manager. I never used it

much, but Roberta liked it. I don't mind remembering that you type `mpower -on` to turn on the WinSX (on the Mastersport, it's `machine modem on`), but Roberta isn't much interested in memorizing details of machine operation. I wrote her a series of batch files for her older Zenith laptop. They'd turn on the modem, log onto the right directory, and invoke the proper communications program for BIX or GEnie. I didn't get around to that with the WinSX, because it had Lap Manager.

I'll have to do it for the Nomad, unless I find a way to install Lap Manager on it. While I'm at it, I'll jigger the AUTOEXEC.BAT file to give my name and fax number when the machine turns on. I'd done that on the Zenith laptop before it was stolen, and that's how the San Diego police knew to call me when they recovered the machine.

Roberta thinks all laptop machines ought to come with good on-line help systems describing the machine and any preinstalled software. Many outfits put up readme files, but they tend to be too long and unindexed. What Roberta wants is hypertext on-line help files. She also points out that USRobotics prints the essential information from their manual right on the bottom of the modem. There's a lot of blank space on laptop bottoms....

RoboHelp

If you have an application that can benefit from hypertext help systems for Windows, you need RoboHelp from Blue Sky Software. This really works to take the sting out of building help systems. The author of RoboHelp—who, curiously, is unnamed—says in the preface to the manual that "the day of the ASCII read-me file is over." With luck, this is true.

RoboHelp requires Microsoft Word for Windows, Microsoft Windows 3.x, and the Microsoft Help Compiler 3.x. Given those, you can build hypertext help systems for just about every Windows application.

Using RoboHelp is straightforward. You'll need to know a bit about Windows and Word for Windows and how to use the Microsoft Help Compiler; otherwise, it's all explained simply enough. Do understand, this is a professional tool, but anyone who can use Word for Windows can use it. That certainly includes teachers.

I strongly recommend that anyone distributing a Windows product, or hardware with Windows installed, build real help files to include with the product. You'll make your customers much happier and end a lot of reviewer frustrations. RoboHelp looks to be the simplest way to do that; this makes Blue Sky a public benefactor and more than justifies a User's Choice Award.

Cursorific Pro

I'm still writing this in Q&A Write, but I'm now used to Windows and Microsoft Word; enough so that I've taken to running Windows on the Mastersport. The only problem I had with that was that I sometimes had trouble locating the Windows cursor on the desktop.

That was just about fixed by Cursorific Pro from Aapex Software. This installs simply, ending up as a resource in your Windows Main program group. Invoke it and choose cursors for different conditions. You get a lot of cursor sizes, patterns, and shapes to choose from. One of them will be visible in almost any light condition.

This is one of those programs that does one thing, does it well, and causes no problems. If you have any trouble at all seeing your Windows cursor—or if you're just

bored with your cursor—this is the program to get. It sure saved me some eyestrain. Recommended, and the winner of a User's Choice Award.

K-U-I

If you don't care for trackballs and you have to run Windows on a portable, Softac's K-U-I—Keyboard User Interface—may be just what you need. This lets you set up a bunch of hot keys to launch applications, simulate a mouse, and do command-line control in a pop-up window. K-U-I also includes user-selectable cursors.

I find I don't at all mind either the Microsoft Ballpoint or the Logitech TrackMan Portable, so this isn't as useful to me as I thought it would be when I got it; but if you're tired of mousing around, this may be the remedy.

The Amiga 3000T

This is a report, not a review. I don't have the time or space to go into all the features of the Amiga 3000T and the new Amiga 2.0 operating system. What I can do is give you some impressions and tell you why you might want to buy one.

The Amiga was the first personal computer with a practical multitasking operating system. It also had stunning visuals integrated with a good sound system, so it was the first practical low-cost multimedia machine as well. As a result, it attracted quite a few users. Most were hobbyists. Some dropped along the wayside, but a few, like my colorful friend Leo Schwab, became real fanatics who thought themselves Keepers of the Sacred Flame. They went around denouncing IBM, which may or may not have helped get others to take the Amiga seriously.

Others, like David Joiner and Joanne Dow—you can find them on-line in the Amiga conference on BIX—were willing to overlook the machine's many and very real defects: weird documentation—many of its best features weren't documented at all, and they were passed along as folklore; a slow and insanely dumb disk drive system; hokey error messages; a start-up system that was just plain odd, involving a "Kickstart" and an icon-operated "Workbench," except that power users could use a command system called a CLI (command-line interface); mysterious terminology; and so forth. Of course, some of these were strengths rather than defects, but the early Amiga was so poorly documented that many features were as confusing as bugs.

There were a number of revisions, and promises of more, but over the years the Amiga lost several chances to move up to real rivalry with the Mac. On the other hand, it's still here, with about a million units in the U.S. and perhaps 3 million worldwide; and while sales aren't exactly leaping along, they're not all that slow either. The Amiga has found a definite niche; and those who like it, like it a lot.

Moreover, the new version of the operating system that is incorporated into the 3000T fixes most of the problems described above. The floppy drive system is still a bit weird, but it's no longer intolerably slow. The hokey "Guru Meditation" messages you got if there was a system crash are gone, and, even better, so are the system crashes. The new operating system boots up from ROM and comes up when you turn on the machine: no more two-stage Kickstart-Workbench bootup. The operating system has many features you won't find in DOS systems, too.

For instance, quite good sound rendering is built in: no sound board is needed to

get multimedia. The ProWrite word processor (it's much like MacWrite in use) will have the Amiga read the screen to you. It does a surprisingly good job, too.

Arexx, the Amiga version of the Rexx command programming language, is built into the Amiga operating system. Rexx is a very powerful language that lets you build highly complex and useful software robots to handle such things as communications and backup unattended; experienced Amiga users can do astonishing things with it.

About the time you read this, there will be a new addition to the Amiga 3000T operating system: the ability to read DOS files directly. That is already installed on my system. It makes text and source code transfers very easy. The 3000T I have has a high-density 3½-inch drive; that's at present an undocumented feature, but I presume Commodore will document and support it soon.

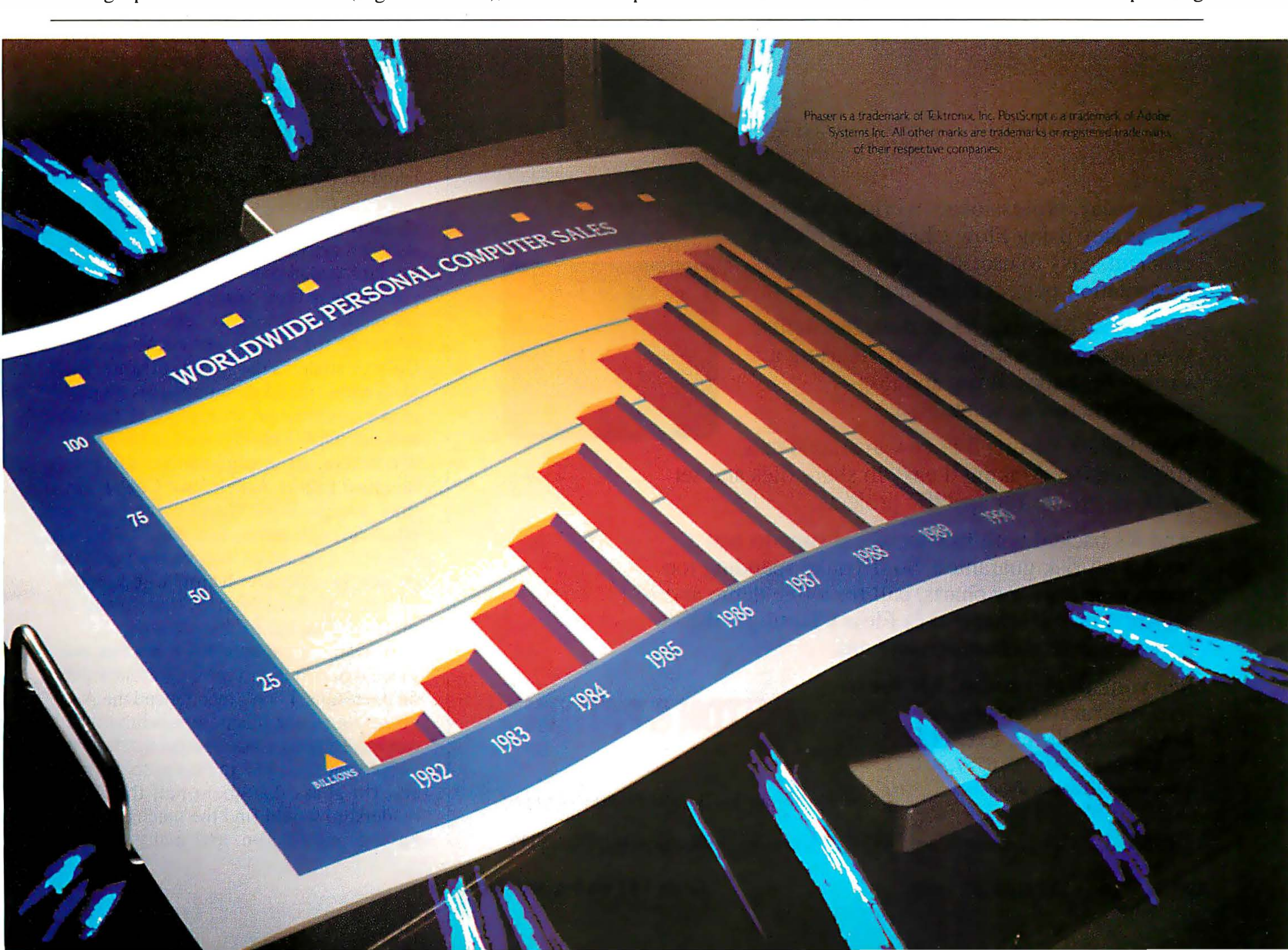
The Amiga 3000T has full SCSI capability. Attach any true SCSI device, including a hard drive, and it ought to work just fine; no controller card is needed. We tested the Amiga's SCSI capability by connecting up the Palindrome DAT (digital audiotape) drive that normally runs off a Future Domain controller card. There was nothing to it: just connect it up, put in a blank tape, and bring up the backup program.

The current version of the backup program isn't very sophisticated.

The current version of the backup program isn't very sophisticated: it will do only incremental backups to a new tape, otherwise only full backups on a previously used tape. On the other hand, it works just fine, and it's fast (at least with DAT), so I can't complain. It will restore single files or *drawers* (which is what directories are called on the Amiga). We erased some games and restored them from tape, and they ran as well as they ever did. I am told that any SCSI tape drive, such as those from Colorado Memory Systems, will work with the Amiga.

The next test was CD-ROM drives. First we tried a Denon drive (manufactured by Sony), which is supposed to be true Mac-compatible SCSI. It didn't work. Then we tried the Toshiba CD-ROM drive that came with the Corel Blockbuster package. That worked first crack. The Denon drive is older, but it works with most SCSI devices; I don't know why the Amiga 3000T didn't like it. The Toshiba is easily the fastest CD-ROM drive I have; it works just fine. So does the Pioneer read/write optical drive. An Amiga doesn't know about WORM files, so you can't run a WORM drive. All SCSI devices are not equal. I don't have any advice on how to tell which will work with the Amiga and which won't.

SCSI devices appear to the Amiga operating system as just another drive. The CD-ROM retrieval software I know about is all written for DOS or Mac operating



systems; I'm not aware of any for the Amiga. We were able to read DOS directory and filenames all right, and text files; but we couldn't run any of the retrieval software. We were able to view some CD-ROM screen images.

Art Department Professional is a wonderful program that converts just about any screen image format to something the Amiga can display, and we were able to look at, for instance, NASA GIF files just fine. The VGA quality is excellent, but then you expect that from the Amiga.

Indeed, desktop video is the Amiga's strongest point. It's easier to make a good desktop presentation integrating visuals, animations, and sound with the Amiga than with any other system I know; certainly than with any PC-type system. Moreover, Amiga stuff can be output to tape and then played on any VCR: I recall a spectacular presentation by Klaus Heiss at Doug Trumball's studio in the Berkshires. It was a series of solar-sail spacecraft, drawn and animated by Georgetown University students using an Amiga 2000.

I'm supposed to do another space presentation at the White House, and I think I'll work up something on the Amiga. I've got some scanned images of my ships, there are plenty of space images for background, and Disney makes an excellent animation program; and there are several programs that will build presentations. Stay tuned.

I wouldn't recommend the Amiga as the only computer for a small business. You can manage: There are reasonable word processors, databases, and spreadsheet programs for the Amiga; but you will be out of step with everyone else. I'd hate to do my income taxes without Taxview or MacInTax, and there are many small businesses using Quicken or Access to Platinum for accounting; neither of these has an Amiga version. My artist friend Kelly Freas likes the Amiga because of the graphics, but his wife finds the business software is driving her nuts. Of course, they haven't bought any new software in years. Still, in my judgment they'd do better to get a PClone for the business and leave the Amiga for graphics and games.

The Amiga is used as a solo business machine in Europe, and knowing the Amiga and its European software base may be an edge for those wanting to do business over there. There's also a simple program that will change the Amiga video output from U.S. NTSC to the European PAL standard (which has more scan lines).

The Amiga fares better as a solo machine for students, provided that the student is curious about the machine's potential. Amiga users will get a very good grounding in both basics and slick tricks of computer use; Windows or the Mac should be a snap for an experienced Amiga user. College students may need software, such as dynamic simulation programs, that just aren't available on an Amiga; on the other hand, while I haven't seen it, Dr. Marvin Weinstein, an Amiga enthusiast at the Stanford Linear Accelerator Center, says that Amiga DOS Maple is as good as Mathcad or Mathematica. Most of the big CD-ROM databases don't have any Amiga access software. It might be possible to write an Arexx script that would do much of that, but I'd hate to try it.

Actually, it might be fun to try that, provided that you didn't have a fortune riding on the results. I don't recommend the Amiga as your only business machine, but I can recommend it as a second machine for people who just like to play with computers; I'd guess that about half the BYTE readership would find the machine worth having just for fun, and many of those

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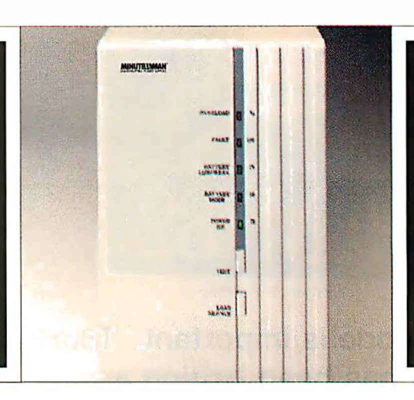
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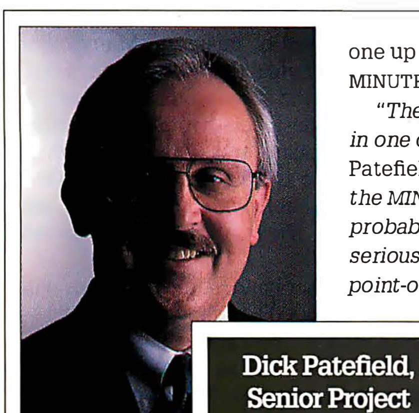
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Dick Patefield, Senior Project Manager for Store Systems Support, JCPenney

Recently JCPenney Co., Inc. changed its operations from the old POS systems to the new PC-based technology, relying on PC platforms for point-of-sale and in-store support. And they back each one up with help from MINUTEMAN.

"There was a violent surge in one of our stores," says Patefield. *"If we didn't have the MINUTEMAN unit, it probably would have seriously damaged all of our point-of-sale equipment.*

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would see some business potential in the desktop video capabilities of the machine. I could have made the same statement about the Amiga 2000, but that machine was much harder to use, so many would have given up before they got started. The 3000T, with its new operating system and better documentation, is much less dependent on folklore workarounds.

On that score: the folklore is available for those who want it. The Amiga users groups on GEnie and BIX are about the largest machine-specific conferences going, and the Amiga community enthusiastically tries to help anyone with a problem. If this column makes you curious about the Amiga and you want to know more, my advice is to get on BIX and talk to Joanne Dow (BIX name "jdow").

The Amiga is also said to be the best games machine around. Alas, so far I have been unable to get many of my older Amiga games to work with it. Pirates, from Microprose, for example. The game begins spectacularly, much better color and animation than the Mac version; but within 5 minutes it locks up and has to be reset. (I'm told there is a hacked version that does run with the 3000T, but I haven't seen it.) Firepower, a wonderful two-player tank-simulation game, won't run at all, and MicroIllusions, the company that produced it, is out of business. Many other older games defeat themselves: the 3000T can't handle the copy-protection schemes. Some game designers wrote directly to the 2000's hardware and ROMs, and while Commodore tried to make the 3000T ROMs compatible with the more common programmer tricks, they weren't always successful.

On the other hand, some programs will degrade the 3000T to slow games down—Populous I is spectacular on the Amiga, but it runs far too fast on a 3000T—and other programs will hack out the older copy-protection schemes and let you install the games on your hard disk.

It used to be that, because of the Amiga's spectacular graphics and sound integration, there were more games for the Amiga than for any other machine. Now that the Mac has color and VGA is fairly standard on the PC, developers tend to write for the larger market and then port back to the Amiga. This often fails to take advantage of many Amiga features, so the Amiga versions of games are no longer necessarily much better than the PC versions; and some major games never are ported to the Amiga.

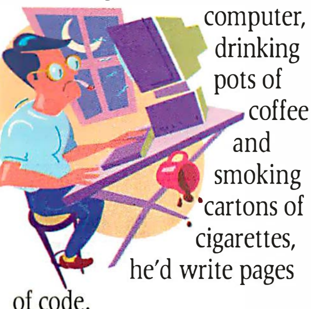
For all that, the Amiga has a real niche, and while sales aren't spectacular, it's here to stay. If you need desktop video, you may be able to justify getting one for that;

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He wasn't famous. He didn't drive a fancy car, but dressed in his favorite Comdex T-shirt and faded blue jeans, he set out to change the course of the computer software industry. Quite a task for a lonely software developer.

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but you may find yourself using it because it's just plain fun.

Word for Windows

The adventure continues. I've just got a copy of the CD-ROM version of Word for Windows; it's integrated with Microsoft Bookshelf. Provided that you have a CD-ROM drive, it's neat, what with integrated thesaurus, dictionary, Columbia desktop encyclopedia, and other stuff, all built into your text editor. They've also put the entire Word for Windows manual on-line: the CD-ROM is completely filled, 600 MB of program and information.

I haven't had my copy long, but I've already told Larry Niven to order one. More next month, but I think this is my word processor for the future.

CD-ROM Interim Report

Everyone needs a CD-ROM drive, and they're now down to a price that anyone can afford; I've seen drives with a stack of CD-ROMs in the DAK mail-order catalog for under $200. Of course, the cheaper drives are very slow. You'd do better to spend another hundred for a faster drive. A slow CD-ROM is still better than no CD-ROM at all, but you can use it only for text retrieval, not multimedia.

I think I was the first columnist to predict a big future for CD-ROM; that future is here, and in a couple of years you'll no more have computers without a CD-ROM drive than you'd have one without a hard drive.

One painless way to install CD-ROM is to purchase the Multi-Media Kit from Creative Labs. This package consists of a Sound Blaster Pro board with a SCSI controller, an internal half-height CD-ROM drive, and the software upgrades needed for multimedia operation with Windows 3.1. The result is a good, solid, fast CD-ROM drive.

A second way is to contact the Bureau of Electronic Publishing (141 New Rd., Parsippany, NJ 07054, (800) 828-4766 or (201) 808-2700; fax (201) 808-2676) for their catalog and decide what to do from there.

I've also had excellent results with any SCSI drive and Corel's SCSI controller board and software. Corel has the added advantage that it works well with the Pioneer Minichanger, which is coming into its own. In the future, I will want one CD-ROM drive just for the Microsoft Word/Bookshelf integrated package; I can foresee when I will want several CD-ROMs on-line at all times and still need a drive for CD-ROMs used occasionally. The Minichanger is the obvious solution to that; indeed, my own setup now has a very fast Toshiba CD-ROM drive in a daisy chain with the Minichanger.

However you do it, you will soon find you can't do without CD-ROM.

WinJet and LaserMaster

I've mentioned LaserMaster before. Their products come in two flavors: WinJet 800 and LaserMaster TrueTech 1000/4, which is a big laser printer. WinJet 800 converts your LaserJet II, IID, III, or IIID into an extremely fast PostScript printer with 300- or 800-dot-per-inch resolution.

The TrueTech 1000/4 is about the same speed, but it has 1000-dpi resolution. Alex and George Jumper installed the TrueTech 1000/4 on a Novell network system, and aside from a couple of glitches having to do with sequencing—the software must be installed before the hardware board is put into your PC, and the print output has to be directed to the proper queue before

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entering Windows—they had no problems.

Their report concludes: "It becomes obvious why the LaserMaster people include the acid-free high-quality bond with their machine. The test sheets look so great you hate to throw them away. All in all, quite impressive."

They've since installed LaserMaster printers at a couple of client installations, and everyone is happy. My publisher, Jim Baen, has typeset several books, including one of mine, in-house with a PostScript printer; I've recommended that he purchase a TrueTech 1000/4 and do all of my

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forthcoming books with it.

WinJet 800, meanwhile, is plenty good enough for anything but slick paper typesetting. It, too, installs simply. A board goes into your PC, and an interface board goes into your LaserJet. The only problem is that the cable between the two boards is only 10 feet long; my printer and computer are not 10 feet apart, but the cable route is longer than that. WinJet 800 works so well, though, that I'm looking into ways to change the cable route so that I can keep it; which probably says all that needs saying.

WinJet 800 takes all the sting out of Windows printing. It's fast and reliable, and the results are beautiful. A User's Choice Award, and highly recommended.

Windowcraft

I haven't time to do this justice this month, but you'll be hearing about it a lot in the future. This is to Windows what HyperCard is to the Mac: an authoring system for developing Windows applications. It will automatically convert many Mac HyperCard stacks to Windows. It makes objects. It includes a paint program. It has a built-in debugging tool. It's powerful enough that I could use it to do a jazzy Windows version of Roberta's reading program, and that's likely to happen soon.

In a word: Windowcraft is what ToolBook should have been; it's what Windows has been waiting for. A lot more later, but if you're interested in developing Windows applications, you can't afford not to know about this.

Winding Down

Many books this month. Microsoft Press has a stack of Word for Windows books, all with some value, but you're probably better off getting the CD-ROM version of Word for Windows: it has the Word manual on-line, and it's much better indexed than any book index I've seen.

The computer book of the month is by Michael A. Banks, *The Windows Shareware Book* (John Wiley & Sons, 1992, ISBN 0-471-55817-6). I'd be astounded if you didn't find at least one of the shareware programs included worth the price of the book, and Banks does a good survey of the shareware scene.

The book of the month is by James Davidson and William Rees-Mogg, *The Great Reckoning: How the World Will Change in the Depression of the 90's* (Summit Books, 1991, ISBN 0-671-66980). I guarantee you won't agree with it all, but I bet you can't put it down once you start it.

The game of the month is Interstel's Dusk of the Gods. I guarantee the interface will drive you nuts, and you'll curse some of the implementation; but it's based on real Norse mythology, and provided you're interested in the Aesir and Vanir, it will be one of the most *interesting* games you'll ever see.

Next month, a wonderful science adventure game, operations research at Microsoft, new sound boards, and much more. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."



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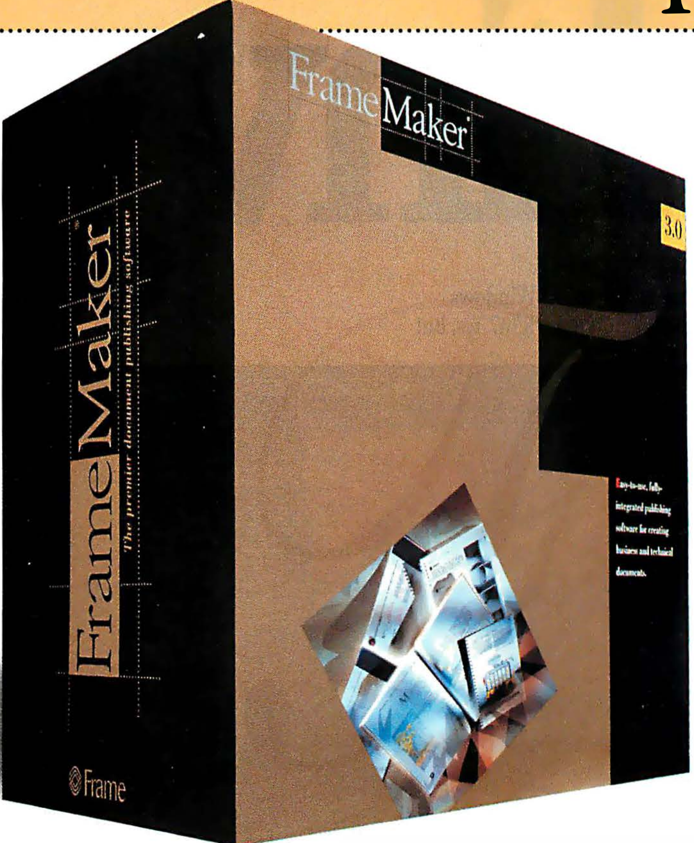
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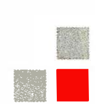
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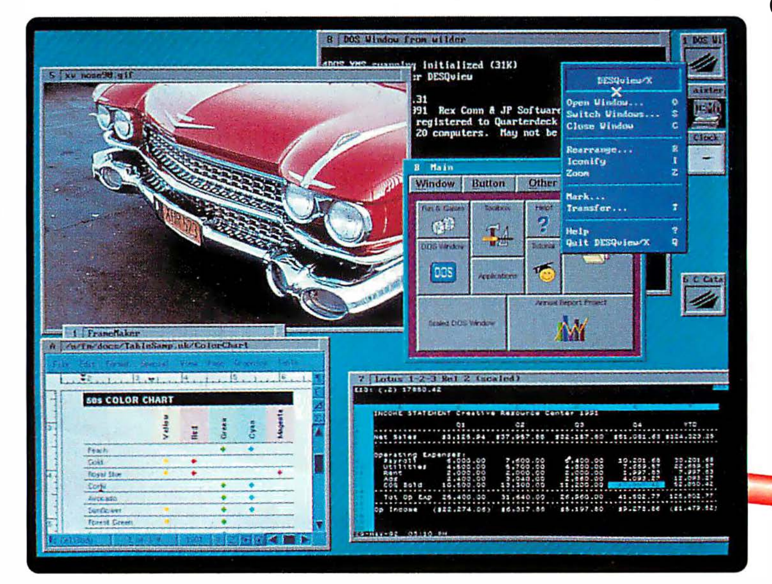
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End PC Envy

A Window on the Network

As you can see, DOS programs run alongside Microsoft Windows programs. You've seen this all before in our DESQview, right? Yes, but now there's more. DESQview/X lets you access and control a wide variety of PCs and workstations through your own PC. This feature is called remote computing.

In the example to the right, Lotus 1-2-3 is running in its own 386SX PC. The window at the top of the screen is a DOS window running on a remote 486 PC under DESQview/X. At the lower left is a FrameMaker program running on a remote IBM RS/6000 workstation in another part of the company.



Brand and Platform Freedom

DESQview/X runs on 386SX PCs and above. And from within windows on those PCs, you can use programs* running on any number of remote DESQview/X PCs if your network supports NetWare or NetBIOS. Add DESQview/X's optional Network Manager for TCP/IP networks and you can also access programs running on IBM RS/6000s to HP 9000s to Sun workstations. And it works the other way, too: these workstations can view and use DOS programs in their displays.

* DOS graphics programs currently run only on your local PC.

Works the Way You Want

You can change menus, add sub-menus. Add menu items that run remote programs. Change commands. DESQview/X gives you a menu to use for your macros. And if you prefer a graphical desk top instead of a menu, DESQview/X's Application Manager gives you buttons for opening a set of programs used in a project or even for launching remote programs. What's more, you can specify window size and color. And if you are using DOS text programs, you can set them up so that the font changes size as you change the size of the window. We call this feature scalable DOS windows (see the Lotus 1-2-3 window at left).

Looks the Way Users Want

DESQview/X supports sculptured menus, customizable backgrounds, graphic buttons for launching programs, icons and online context-sensitive help to make computing easy and fun. If you are a DESQview user, you'll find DESQview/X very familiar, with an improved look. But if you prefer a different look and feel, we offer two other interface options: OSF/Motif and OPEN LOOK.

Introducing DESQview/X™ for DOS

DESQview/X gives everyone access to the power of the fastest PC—or workstation—on the network.

Remote Computing is a Reality

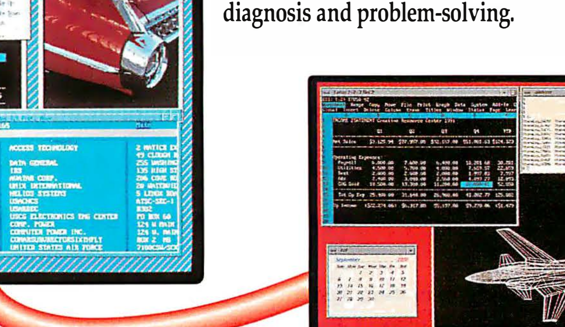
Set up and run programs on remote DESQview/X PCs on your network. Instruct and support users. Diagnose problems and solve them from your own PC. DESQview/X provides controlled access to every program on every PC.

Easy to Set Up and Administer

DESQview/X asks three questions: Do you wish to transfer files to and from other computers? Do you wish to use programs on other computers? and Do you wish other people to have access to programs on your computer? That's all it takes for DESQview/X to set itself up. DESQview/X incorporates QEMM-386 to assure maximum memory utilization and Manifest for easy diagnosis and problem-solving.

Here's How You Might Use DESQview/X on Your Network:

Say for instance your company uses a particular database that requires lots of horsepower or lots of memory to run. You can set it up on a 486 PC loaded with memory—then allow appropriate users access as you normally do on the network. The difference is that the database will be running on the remote 486 instead of the local PC. Users can take advantage of the power they need, when they need it. And you'll be able to best assess who actually needs his/her own 486 PC.



Give your PC the key to unlocking and sharing the power of other PCs on the network.

DESQview/X is a graphical multitasking environment for DOS. It is so powerful that it literally turns DOS PCs into graphical workstations. With DESQview/X, you can run DOS and Microsoft Windows programs simultaneously, view them in windows, transfer between them, create DESQview/X-global or program macros and manage your files.



DESQview/X makes computing lots easier, more productive, and more fun.

With DESQview/X, you can now run programs and access files on other computers on the network and view them in windows on your own PC. Distribute tasks among computers based on their capabilities and available resources.

Remote diagnosis and support is now a reality. With DESQview/X you can support, instruct; even remotely demonstrate programs right at your user's computer.

If you have X Window workstations, our optional 'DESQview/X to Other X Systems' TCP/IP Network Manager allows you to run workstation programs remotely from PCs.

For all this power, DESQview/X is stunningly easy to set up and use, and can run on any 386 or 486 PC with as little as 4MB RAM and 40MB hard disk.

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Is Unix Dead?

As Unix faces the stiffest competition of its long life—Windows NT—can it survive?

TOM YAGER AND BEN SMITH

Among operating systems, Unix is the grand old man. Over its long life, it has garnered respect and ridicule, awe and animosity. Never before has computer code managed to so passionately galvanize and divide, anger and excite otherwise level-headed technologists. Unix stories transcend reality. Wizards and demons abound. Gatherings of the faithful generate the kind of excitement usually reserved for evangelists' tents.

Today, however, Unix's seniority and mystique hold little sway. At least 25 different Unixes exist now, and committees dispassionately choose from among various Unix versions, but six providers dominate: Sun Microsystems, The Santa Cruz Operation, Hewlett-Packard, Unix Software Laboratories, DEC, and IBM. The entry of Next, Univel (the joint venture between USL and Novell), Solaris (from SunSoft, Sun Microsystems' software subsidiary), and other new multiplatform Unix players will, odd as it may seem, help consolidate a confusing field of choices. But in the midst of that consolidation, Unix will face what may be its most powerful adversary to date: Microsoft Windows NT.

At this crossroads, it is appropriate to examine some key aspects of Unix: What makes it unique? How has it changed over the years? What are the threats to its survival, and how might it overcome them? And, most important, will it survive?

Reports Greatly Exaggerated

Despite its problems, Unix is not dead; in fact, it's surprisingly healthy. Unix remains compelling because it is the only operating system to offer multitasking, graphics, and cross-platform compatibility in one package. Market researcher Dataquest estimates that, for 1991, Unix sales (including both systems and operating systems) totaled 1.2 million units, for $18.2 billion in revenue. Unix revenue will climb to $44.7 billion in 1996 on unit sales of 4.1 million, according to Rikki Kirzner, a senior industry analyst in Dataquest's software group (see figure 1).

Other analysts believe that Windows NT will slow Unix's growth. NT is a legitimate threat to Unix's domination of the workstation market and to its chances for success on the desktop. NT may be the strongest stimulus to date for inducing Unix providers to stop arguing and start cooperating in an endeavor to give software applications developers a standard software base. The Unix industry has answered that call with new versions aimed at the Intel-based desktop: USL's Unix System V release 4.2 (also known as Destiny), Next's NextStep, and SunSoft's Solaris.

continued

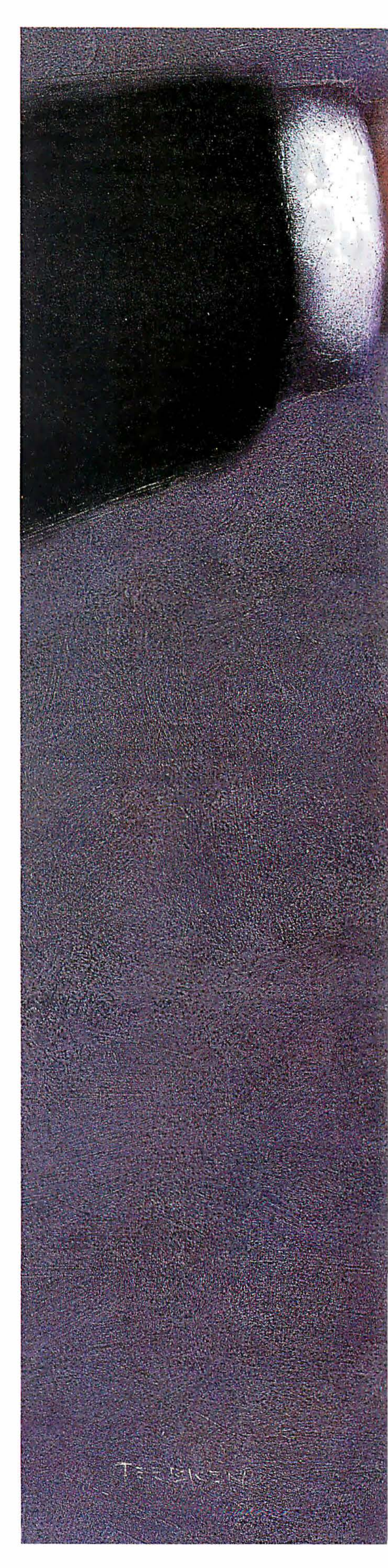
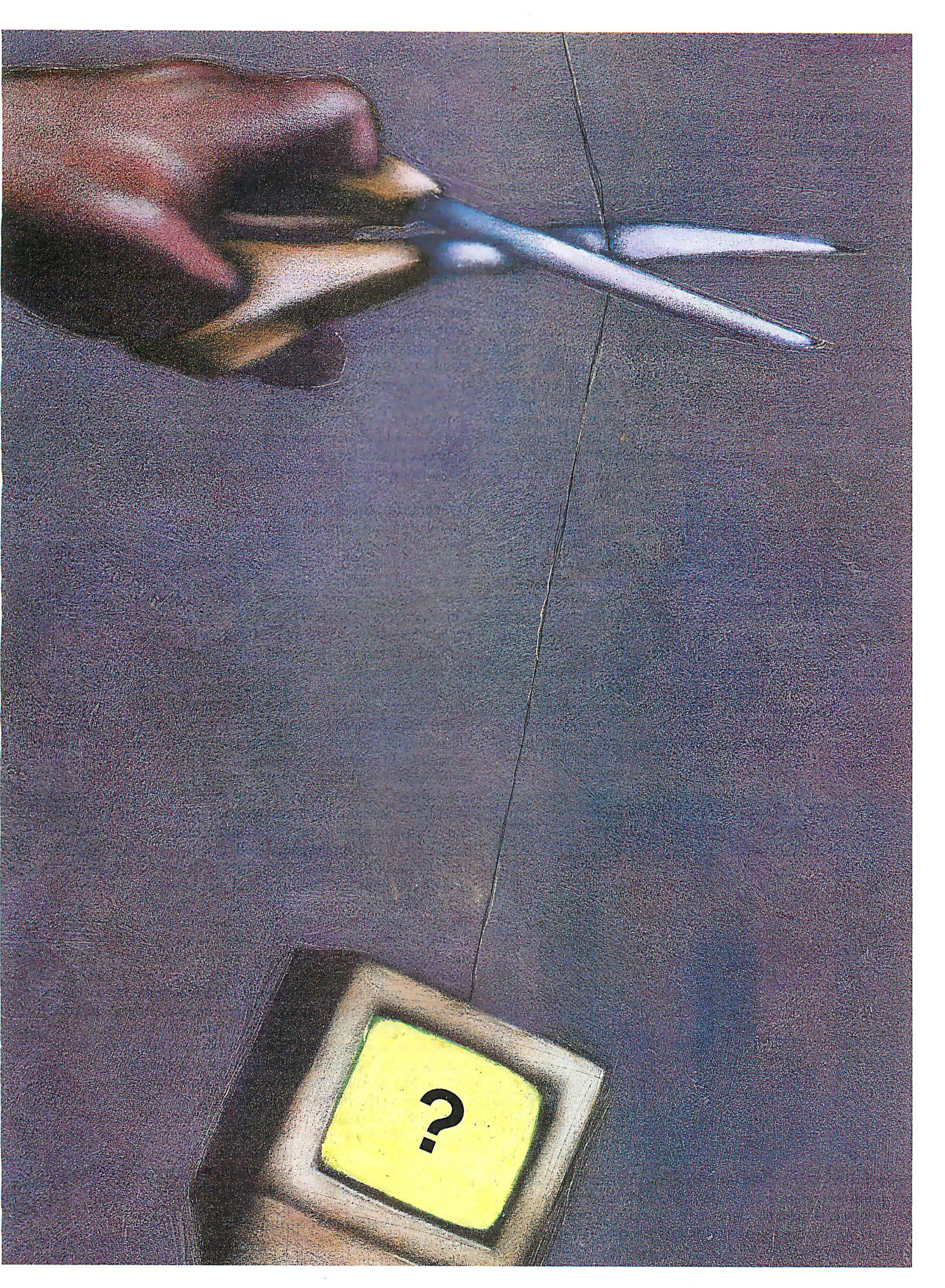


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Understanding the Unix Community

There are two distinct branches of the Unix user community. The first group could just as well be running VM, VMS, or any other operating system; it just so happens that its chosen applications run on Unix. These unwitting people may be the fastest-growing segment of Unix users. Participants in many information services—AT&T Easy Link, for instance—are Unix users and not even aware of it. Many retailers run their businesses on Unix. What these users have in common is that some technically knowledgeable person or firm set up and maintains their systems. For this group, Unix is an invisible tool.

The other, better known, Unix community comprises technically adept users, for the most part. They may be using workstations now, but they are the people who were running serial terminals not long ago. In contrast to the first group, these users understand the inner workings of the operating system. This uniquely dedicated group forms the core of the "Unix community," a near-cult with a strict hierarchy based on technical knowledge (see the text box "Unix: A Child of a Thousand Parents" on page 137). The people involved in the creation of Unix built it for people like these. But now that Unix is falling into the hands of the uninitiated, its role—and its shape—are beginning to change.

Those blissfully unaware users of the first group are Unix's future. In fact, they're the future for all multitasking operating systems. Ask today's user what he or she needs, and you'll hear multitasking, graphics, and cross-platform compatibility. These needs are keeping Unix alive, because it's the only operating system that delivers them all.

Unix users have come to take seamless file sharing, network printer services, remote application execution, client/server program support, and multiuser access for granted. MIT's efforts with the X Window System have made graphics part of the mix, providing a network-integrated graphical application environment that's still unmatched by any other popular system. These and other services make Unix a perfect choice for networked applications, and Unix is presently the only operating system that integrates these elements.

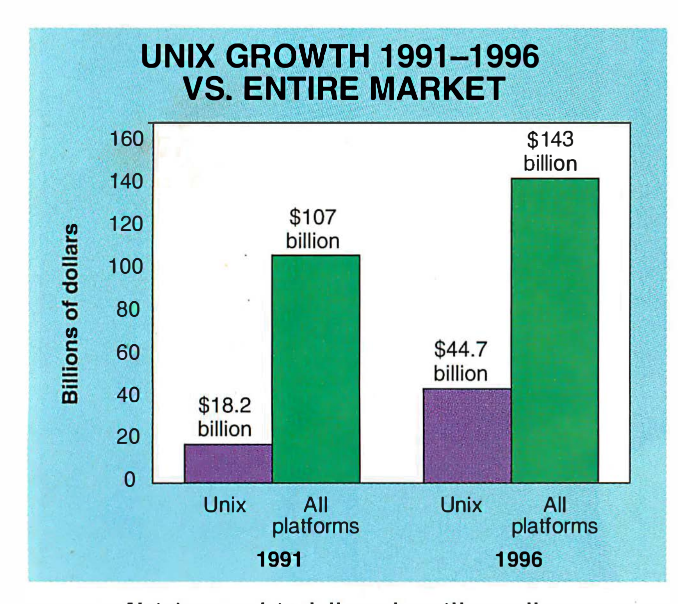


Figure 1: *Unix's growth in dollar sales will actually outpace that of the market as a whole through 1996, according to market research firm Dataquest. The compound annual growth rate for Unix during this period is 27.5 percent, but only 5.9 percent for all platforms.*

Thomas Giammo, assistant commissioner of information systems at the U.S. Department of Commerce's Patent and Trademark Office, agrees: "In the next year or two, there's no other player that can give us what we need," he says.

In spite of that commitment, Giammo echoes the sentiments of both large- and small-scale users who feel stuck with Unix: It solves their short-term problems, but it creates other problems that make it an unlikely long-term solution. Giammo predicts that, as a result, Unix will be effectively wiped out in the mid-1990s; his money's on Windows NT. And he's not alone.

Once Unix became a commercial property, it lost its unity of purpose. In the hands of vendors who knowingly built cross-version incompatibility into their offerings (partly to lock customers into a particular flavor), Unix has generally failed to track user demands adequately. While it meets needs like multitasking and networking well enough, it leaves lesser issues unaddressed. For example, it's still too hard to use and administer, not compatible enough across implementations, and, for the most part, too married to its old character-based, command-line, serial-terminal traditions. "[Unix] is a hacker's version of an operating system that has grown respectable over time," says Giammo.

Overcoming the Problems

Improving Unix is much on the minds of Unix vendors. "If you have an X-based desktop with Mac-like features, the end user won't care that Unix is underneath," says Ken Arnold, an engineer at HP's Distributed Object Computing Program. As base-level machines get more powerful, they can better run the larger Unix operating systems. Then, to the end user, it is simply a matter of what off-the-shelf applications are available.

Avadis Tevanian, director of System Software at Next, agrees. He envisions a GUI that can run productivity applications side-by-side with user-made custom applications. "To get up to millions of units, you have to get rid of [the Unix shell]," he says.

But a GUI has not been an original, fully integrated part of Unix. Instead, it is usually a distinct layer poured over Unix's command line. In contrast, *everything* on the Mac is handled graphically, and the operating system is tuned for it. Even when the system crashes, a graphical dialog box tells you what went wrong. Most Unix systems boot and shut down in full-screen text mode, and when you need to jump into single-user mode for maintenance, you don't get graphical pull-down menus and radio buttons—you get a prompt. For graphics to contribute adequately to ease of use, it must be an integrated part of the system.

The Next machine provides a shining example of Unix with highly integrated graphics. Unless something goes terribly wrong, or unless you request otherwise, you'll always have graphics insulating you from the operating system (see screen a). Even the most experienced users—the programmers—work inside a cozy graphical environment with visual tools that make it easy to develop NextStep applications. There's almost nothing the command line offers that the graphical environment does not.

The Next computer, though not a best-seller, has proved that the concept of invisible Unix is a viable one and that graphical workstations can be safely placed on the desks of general users. Jerry Marger, president of the law firm Marger, Johnson, McCollom & Stolowitz of Portland, Oregon, is a believer. He converted his firm's DOS network to a Next system because of the latter's ease of use and performance. "NextStep is awesome. Operating a Next is like operating a Mac, except that it's got a truck engine instead of a four-banger," Marger says.

PC Unix: Waiting for Standards

Plagued by bugs, incompatibilities (particularly in graphical and networking applications), and a lack of cohesive standards, PC

Unix: A Child of a Thousand Parents

In the view of many, Unix is a living, evolving child with thousands of parents. If some Harvard M.B.A. had seen the plan for Unix in advance, the project never would have got off the ground. But for a time at least, Unix soared, and the concept of development not by committee but by *community* became a model for other large projects.

Not long after a small group of AT&T engineers created the earliest Unix in 1969, the work was taken up by an unaffiliated group: students. The best thing that ever happened to Unix was the handing of its source code to a bunch of kids.

Ken Arnold, now an engineer at Hewlett-Packard's Distributed Object Computing Program, was one of those students. Back in the early 1980s, he was part of the pack at the University of California–Berkeley that created BSD 4.0 Unix. BSD spawned a number of cornerstone technologies and went on to become a foundation for several successful commercial operating systems (including SunOS and NextStep).

"We basically took a lot of people's neat stuff [and] added it to the new things required to make the project go," says Arnold. It was this "neat stuff" that made Unix rich. "Frankly, I suspect most people didn't give a wet ball of lint for its educational value. It was fun, it was central, and we got to do it," Arnold adds.

Networking, the full-screen editor, the fast file system, and countless other necessities were all born at Berkeley. AT&T and its agents rolled pieces of Berkeley's work into its own product, and some vendors (e.g., Sun Microsystems and DEC) opted to use Berkeley's output directly rather than AT&T's adaptation of it. Even though BSD included AT&T code, that code was part of an older, less expensive version of Unix.

Before long, Unix source code found its way to universities all over the world, and, under the banner of "research," commercial Unix took shape. Students and corporate engineers worked (virtually speaking) side-by-side in what remains the largest and most fruitful collective technical project of all time.

As AT&T raised license fees and imposed increasingly restrictive terms, it forced commercial implementers to look for alternatives. That's how the Open Software Foundation was born. The key OSF members, including HP, DEC, and Apollo, intended to get out from under AT&T's thumb by creating a Unix-like operating system that didn't require paying the latest (and most expensive) AT&T license fees.

The OSF's first product, Motif, took on a quick following as the first commercial toolkit for building professional-looking X Window System applications. OSF/1, a mix of Carnegie Mellon University's Mach kernel (as used on the Next) and IBM's AIX, is off to a shaky start, thanks to vendors who got tired of waiting for it. Other planned OSF technologies, like DCE (Distributed Computing Environment) and ANDF (Architecture-Neutral Distribution Format), have a brighter future.

On the operating-system side, the OSF served its purpose, putting the fear of failure into the giant AT&T, whose Unix Software Laboratories subsidiary now has responsibility for selling Unix. Shortly after the OSF was formed, AT&T spun around and completely revamped its licensing policies.

A Tough Act to Follow

Unix's golden age gave way to an era of commercialization. Instead of getting Unix from AT&T or Berkeley, consumers began getting it from third-party packagers like Sun and Microsoft. The earliest Intel-based PCs ran a derivative of Unix called Xenix, made by the same upstart Microsoft that had created PC-DOS. While Sun and others established beachheads in scientific and technical shops, Microsoft turned Xenix into a vertical-market powerhouse. The workstation market grew by emphasizing single-user performance and graphics. Xenix and other early PC Unix derivatives grew by making it possible to give multiple users access to shared programs and data for the cost of cheap terminals and serial cables.

Once it became possible for ordinary people to run Unix on their desktop PCs, companies sprang up to push the idea. The Santa Cruz Operation was born, the contract-programming shop Interactive Systems went public, and Microport carved out the low end. On the face of it, Unix was everywhere. You could run it on workstations, mainframes, minicomputers, and PCs. And now, a number of hungry vendors were adding their value to Unix.

The value each commercial player added increased Unix's girth but also chipped away at its benefits. As the system grew bigger, it got slower, and the sheer volume of code and number of contributors to it fostered bugs and incompatibilities. The flood of new features meant more for users to learn, and making the system easy to use had never been a priority. Stories of Unix's unwieldy and unreliable nature set the stage for vendors of proprietary multitasking operating systems.

That was the first big mistake: If early commercial adopters of Unix had focused more on reliability and ease of use than on heaping features helter-skelter into the environment, proprietary competitors like DEC's VMS and IBM's OS/2 would have had no reason to exist. The openness that generated such excitement in the early days fermented into separatism. Each vendor created its own flavor of Unix, incompatible with all the others. Details were getting overlooked, and things seemed to get out of control.

How out of control? In 1989, DMR Group, a Montreal-based computer software consulting and services company that has done studies for UniForum and X/Open on the Unix and open-systems markets, found about 25 brands as the result of a survey of about 6000 sites. That number was whittled down to six top Unix versions. According to Andrew Toller, a principal at DMR, the top six were SunOS; SCO Xenix and SCO V/386 (combined tally); HP-UX; Ultrix; AT&T System V release 4.0; and IBM's AIX, which was just beginning to make an appearance.

IS UNIX DEAD?

Unix never made serious inroads on the desktop. Developers who were once excited about the prospect of a stable multitasking PC operating system quickly discovered the volume of problems to be worked around. Unlike DOS and Windows, which seem to run on every PC, PC Unix was fussy: You had to have the right processor, bus, drive controller, tape drive, and display card. Software developers also found that they had to create a separate version of their applications for each flavor of PC Unix. While one version of a program can run on every SPARC-based system in the world, the same was never true for PC Unix.

Having so many different PC Unixes is hurting the Unix market. The solution, oddly enough, is to fill the market with a new batch of incompatible PC Unixes from the likes of Univel, Next, and SunSoft. There's some hope that, with the new high-profile players, some de facto standards can be struck. They'll be largely proprietary standards, but the success of Apple and Microsoft proves that those are the standards that stick.

Public standards can't easily be enforced. When every Unix provider can alter the source code to suit its individual needs, how do you keep providers from creating incompatible versions? By making binary licenses easier and less expensive to obtain, the keepers of Unix ensure that a broad set of functions known to be stable, including graphics and networking, will be part of most copies of the operating system. USL's deal with Novell, for example, gives USL a distributor it can keep a close eye on. There will, no doubt, be those who feel compelled to tinker with this stable code, but USL hopes they'll be so overwhelmed by competitors doing fully compatible releases that they'll get back in line.

USL spokesperson Ry Schwark says maintaining compatibility is not the only reason to leave the source code alone. "One of the reasons we have driven development down to the binary level is to off-load as much development responsibility as possible from the OEMs," he notes. Those OEMs will have to pass on the cost of customizing Unix to their customers—a painful choice in a market of shrinking margins.

Of the PC Unix players, SCO and Next are in the minority. Most of the others are lining up behind USL's SVR4.2 (see screen b). Unlike its predecessor release 3.2, SVR4.2 makes networking and graphics more or less standard elements of the distribution. Some vendors will probably choose to unbundle portions of it, but graphical applications built for SunSoft's PC Unix should recompile for Univel's version without changes.

It's not important that these vendors will ship different sets of standard applications. What matters is that developers will have a predictable standard software base on which to rest their code. There will be no more rewriting applications to make them run on variants of PC-based SVR4.2, if it lives up to its promise.

Next doesn't mind striking out on its own. It's bringing NextStep, based on Carnegie Mellon University's Mach kernel, to Intel-based systems in an attempt to capitalize more on the fervor over Windows than on any renewed interest in Unix. Obviously, it can't deliver binary application compatibility with its own Motorola-based workstations, but if Next can reduce porting of applications to a simple recompile, it has a chance.

Pencom (Austin, TX) has ported its X server Co-Xist from NextStep 2.1 to NextStep 486 2.1, a version that Next never released as a product. "We probably had more problems than some developers," says Chris Chauvin, product manager and principal developer of Co-Xist. He adds that the difficulties had more to do with the fact that Co-Xist has a dependence on the CPU. Pencom succeeded in doing the port by rewriting specific chunks of code that were optimized for the 68020 microprocessor. The rewritten code was optimized for the 486 within a week; the actual code rewrite took only a couple of days, Chauvin adds.

"Other people were having one- and two-day turnarounds" in

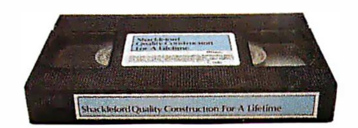
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UNIX VS. WINDOWS NT

Technical issues that are a toss-up between Unix and Windows NT

- Advanced hierarchical file system with long descriptive names
- 32-bit linear memory model
- Preemptive multitasking
- Memory-mapped files
- Shared libraries
- Integral peer networking
- Distributed global naming (assuming LAN Manager NT)

Areas in which NT looks better than Unix

- Threaded SMP (symmetric multiprocessing). Some flavors of Unix (e.g., NextStep) are threaded but lack SMP, while others (e.g., SVR4) are SMP-capable but not threaded. Solaris 2.0 claims threaded SMP.
- Layered device-driver architecture. NT will provide generic disk, display, network, and printer drivers that will allow driver writers to specialize relatively easily to create specific device drivers. Unix drivers are more monolithic and, hence, more difficult to create and maintain.
- Interapplication communication. NT provides well-defined services (e.g., OLE, or Object Linking and Embedding); Unix does not.
- A well-integrated scalable-font subsystem. While SVR4.2 will offer Adobe Type Manager and NextStep has Display PostScript, the dominant Unix GUI, X Window System, still relies heavily on bit-mapped fonts.
- DOS/16-bit Windows support (unproven, but likely to equal or exceed that of OS/2 2.0 and far exceed that of any Unix).
- Source code–compatible applications, with a hugely successful Windows 3.x installed base.

Areas in which Unix looks better than NT

- Multiuser capabilities.
- Distributable GUI (X)—graphical applications are intrinsically client/server.
- Well-standardized basic network services (TCP/IP, sockets, RPC [remote procedure calls]) that work reliably across wildly different hardware platforms and operating-system versions. NT offers a lot of options (named pipes, mail slots, NetBIOS, sockets, RPC, and even, potentially, DDE/OLE, if and when they are made network-aware), but the danger is that there may be no clear path for developers to write distributed NT applications.
- Well-standardized wide-area E-mail.
- Availability for more platforms than are likely, at least in the short term, for NT.

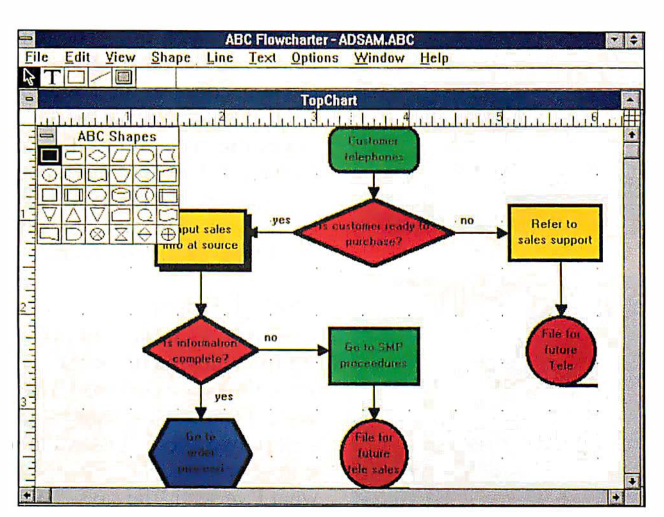
porting Next applications over to the 486 platform, says Chauvin. This lends support to Next's claim of simple recompilation. Pencom will need to port the application again under NextStep 3.0 when Next makes it available in late summer. "Nobody's port will be considered complete until then," Chauvin notes.

Solaris 2.0, a derivative of SVR4, is going to be the acid test for Sun spin-off SunSoft. It remains to be seen whether the software arm of a hardware vendor is truly willing to create a level playing field. Sun is trying to set itself up with a virtual monopoly on SPARC operating systems and, through SunSoft and Solaris 2.0, is planning to extend its reach into the realm of high-end PCs.

The dicey part of this deal is that Sun's hardware side will still be developing its own so tware. Along with countless SPARC and Intel vendors, it will be licensing its own operating system

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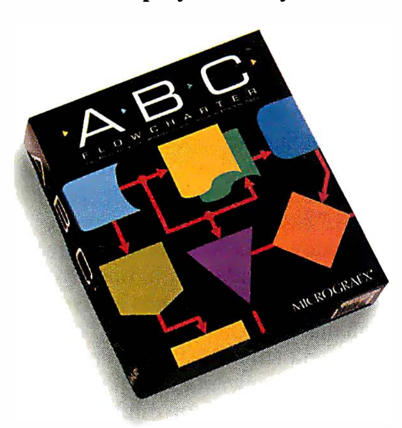
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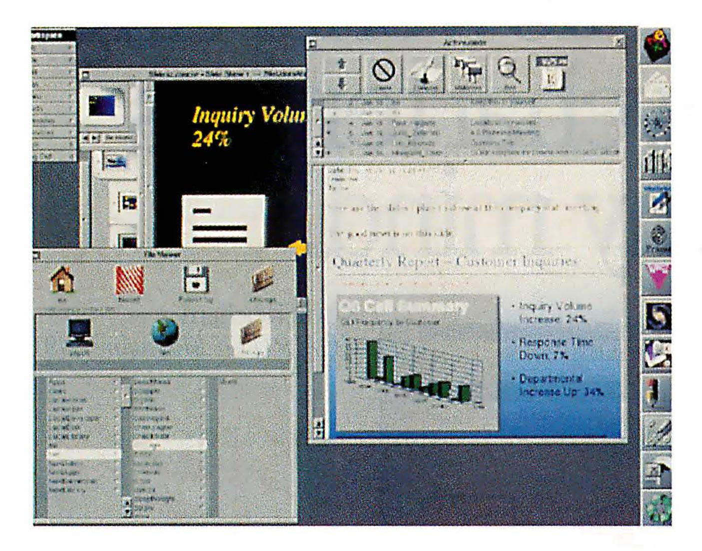
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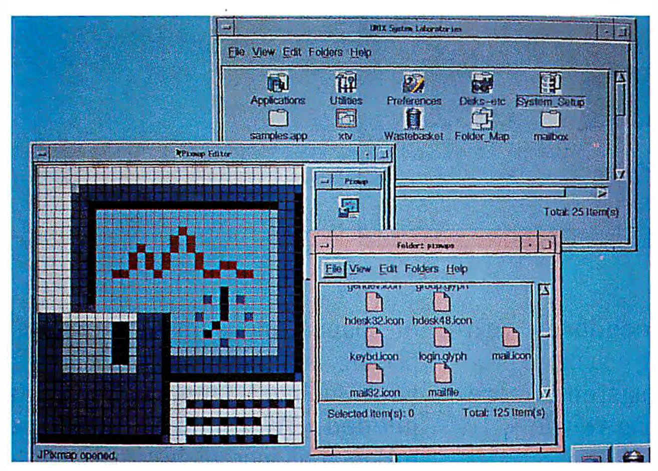
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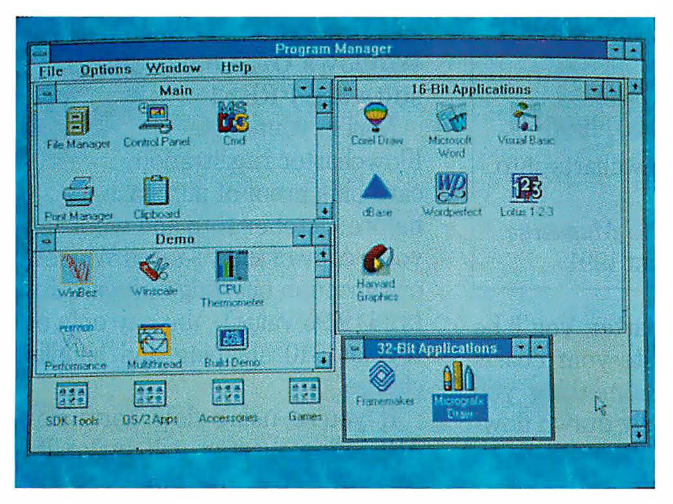
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NextStep (top), SVR4.2 (center), and Windows NT (bottom) all have unique visual traits. NextStep uses heavy shading, floating menus, and animated icons to achieve its glossy twenty-first-century look. SVR4.2's early allegiance was to Open Look, a capable but not popular X interface layer. USL's commercial release will include OSF/Motif as well. Windows NT offers a bridge to Windows users by providing no surprises: It looks, feels, and acts like Windows.

from its own subsidiary, SunSoft. But Sun will have a unique advantage in the added-value department. As new technologies are born, managers at Sun get to choose whether to keep the jewels locked in Sun's safe or share them with the world through SunSoft. In any case, Sun freely confesses its intention of using proprietary enhancements to keep Sun-brand SPARC systems leading the market.

Through all this, SCO is claiming the high ground for its decision to pretty much stay put. Open Desktop 2.0, SCO's flagship Unix bundle, offers little more than previous versions and is still based on SVR3.2. SCO's approach seems to depend on SVR4's failing to catch on. "The conventional wisdom says that Sun, Univel, and so on are going to eat [SCO's] lunch," says Maureen O'Gara, editor of the *Unigram-X* newsletter.

Nina Lytton, president of consulting group Open Systems Advisors (Boston), thinks that developers will be attracted to Open Desktop 2.0 because it is proven and stable. "That strategy sounds like a yawn, but [SCO's] is the low-worry approach for Unix," Lytton says. She also notes that Open Desktop 2.0 will run applications written for SVR4.

The NT Factor

Windows NT is the wild card in Unix's future. Microsoft has a talent for whipping up public support for its products while they're still on the drawing board. The U.S. Patent and Trademark Office, under Giammo's guidance, is pre-sold, but he expects to wait a year or two after NT is available before adopting it, to ensure that it lives up to its promise. He's not interested in Windows: "From what I've seen," he says, "Windows is a kludge. It's even worse than Unix." He blames the "DOS baggage" Windows carries.

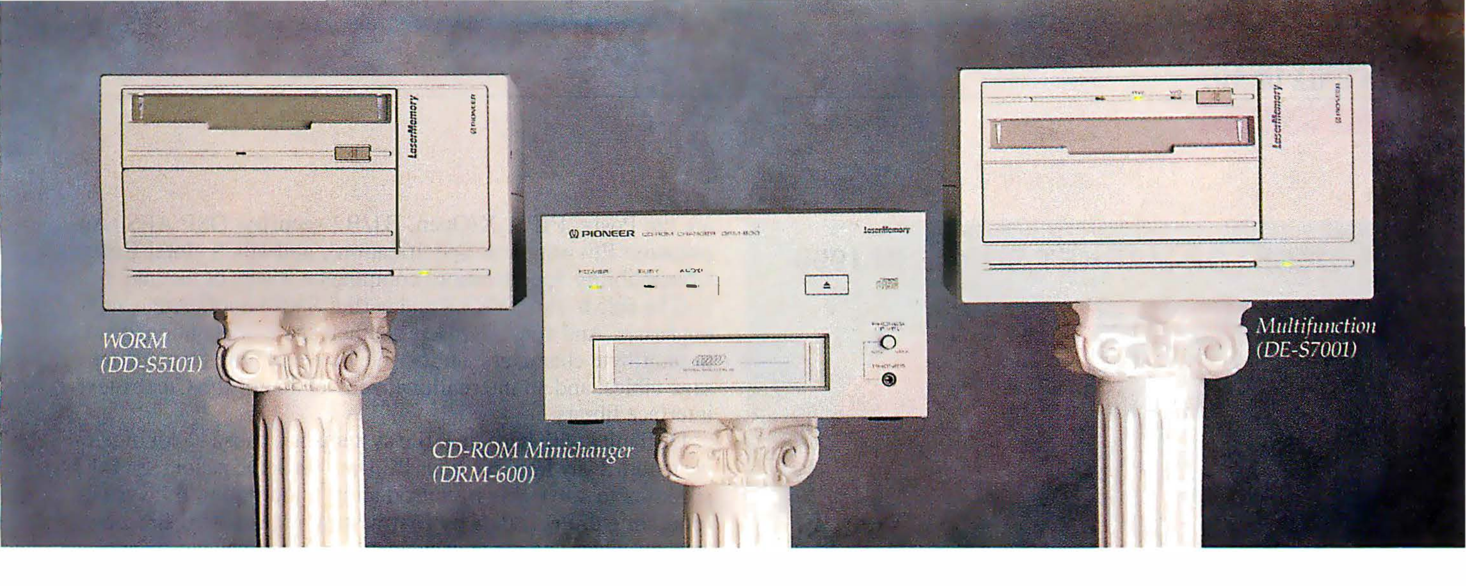
Microsoft claims NT will run DOS, Windows, new 32-bit applications, OS/2 applications, and X applications within an NT window (see screen c). Dwayne Walker, Microsoft's director of Windows NT and networking products, says, "If you had to summarize NT, you'd say it is powerful, scalable, easy to use, and compatible. And it offers multitasking and multiprocessing."

In addition, Microsoft says that NT will have built-in networking, including TCP/IP, and C2-level security. NT is portable from 386 and 486 PCs to RISC environments, supporting the Mips R4000 as well as DEC's Alpha RISC chips. Microsoft claims an advantage for developers, too: The 32-bit Intel-based applications they develop for NT will run native under Microsoft's Win32S extension for 16-bit Windows. With all that, Windows NT is clearly targeted at Unix, becoming what Walker calls "a high-end operating system for desktops and servers just as Unix is a high-end operating system for desktops and servers" (see "Unix vs. Windows NT" on page 140).

Microsoft clout alone could make NT a success. Next's Tevanian concedes that Microsoft's market presence is a big advantage, and according to O'Gara, at least one other Unix provider is worried: "Even the street fighters over at Sun are concerned when they look at what's happening with Windows. They see the way the market works: The users are a bunch of sheep, and Billy [Gates, Microsoft CEO] is the shepherd," says O'Gara.

For Giammo and others, Windows NT sounds like a dream come true, solving all compatibility headaches in one swoop. But with the end-user version at least three months away from shipping, NT is still a question mark. O'Gara calls NT "the unhardened operating system. You can't tell me that this thing is going to be ready to run mission-critical applications anytime soon." And the strength of Windows 3.1 on the desktop might not help Microsoft in promoting NT on workstations.

Open Systems Advisors' Lytton says Unix users are not impressed by the quality of Windows 3.1. "People thought that Windows would be the path of least resistance, but now that



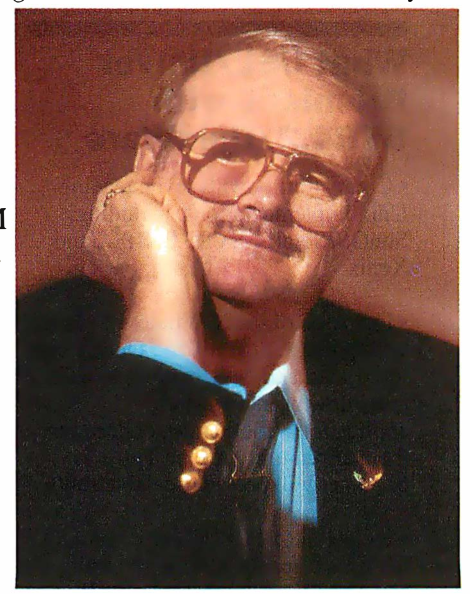
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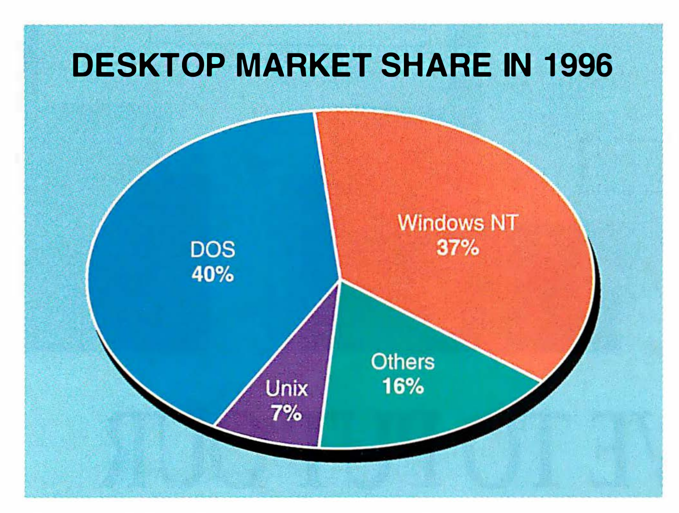


Figure 2: *Although Dataquest expects Unix to have 47 percent of the workstation market by 1996, it will not fare as well in the desktop arena. There, Unix is a distant third at 7 percent, with Windows NT and MS-DOS holding a combined 77 percent market share.*

they've had a chance to really assess 3.1, the vision isn't as rosy as it was," she says.

Dataquest's Kirzner sees a bright future for NT: "We believe Windows NT will be the winner, because you can't stop the power of Microsoft, but Unix will do well," she says. Today, Unix has about 86 percent of the workstation market. By 1996, that figure will drop to 47 percent, due largely to NT. Dataquest projects that NT will claim 37 percent of the desktop market by 1996; DOS will retain 40 percent, and Unix will be a distant third with 7 percent (see figure 2).

Promises, Promises, Promises

While NextStep will be one of the contenders for the high-end multitasking desktop, it appears that the fiercest salvo fired at NT will come from an unlikely alliance: Univel. USL, looking to get serious about marketing and distribution, and Novell, hoping to shed some of its proprietary image in the newly competitive climate, have joined forces to offer a new shrink-wrapped Unix operating system that may be available as early as this fall.

Sold as SVR4.2 by USL and as UnixWare by Univel, it has a list of promises at least as long as NT's. What's surprising is that USL doesn't plan to stake out only the high end Microsoft has targeted for NT: SVR4.2's minimum configuration is a 16-MHz 386SX with 4 MB of memory. USL's literature talks about running the operating system comfortably on systems with 60-MB hard drives and even dares to suggest that SVR4.2 would run nicely on a notebook computer.

For standards, SVR4.2 hits a grand slam. The U.S. government and other large corporate customers will appreciate the Posix, FIPS, X/Open, B1/B2 security, OSF AES (Application Environment Specification), and IBCS (Intel Binary Compatibility Specification) compliance. Users of the Intel port will be able to run SVR3.2 and earlier SVR4 applications without hassle. And non-U.S. users get their share of attention, thanks to multibyte characters, alternative date and time formats, message tables, and an internationalized version of the Curses text-interface library.

Difficulty with hard disk file systems has caused a lot of people to turn away from previous PC Unix implementations. SVR4.2 proposes to solve this by introducing a journaling file system. Journaling protects data by first writing it quickly to a reserved area on disk. Then, when the system has time, the journal is flushed and the real file updating is done. At that time, the various Unix file-system data structures on disk are updated as well. Once it has written the data and updated the structures, the operating system deletes that journal entry and moves to the next one.

In the past, data was transferred from the memory buffers directly to its final destination on disk. If you turned off the power or reset a running system, chances were there would be several files in various states of incompleteness, where either the data or the file-system structure would be out of sync.

Modern Unix file systems write disk information in a predictable order that lets a utility called `fsck` comb through the file system and make sense of it again. But with journaling, that, presumably, won't be necessary. To bring the system up to date, you just play back the entries remaining in the journal. Eliminating the need for frequent file-system cleaning also greatly reduces the time required to reboot a system.

Univel is slimming SVR4.2's size and price by unbundling, breaking with the "everything in one box" tradition. But SVR4.2 is hardly stripped down; both the client and server versions include X and graphical shell support, source-level compatibility with seven common Unix implementations, DOS and Windows support, and networking. USL's role in this is to break with its own tradition of leaving most of the porting job up to licensees. USL will develop targeted binary versions of SVR4.2 (Intel, SPARC, Mips, RISC System/6000, and HP PA RISC versions are promised) and license them to packagers ready-to-run.

Those packagers, with Univel among them, can focus on adding value rather than on doing the basic port. The Intel version will ship from USL with drivers for a variety of display, disk, and SCSI devices. One frequent gripe about X—its dependence on bit-mapped fonts—will be answered by Adobe Type Manager, which will be a standard part of SVR4.2. And SVR4.2's desktop manager will include productivity applications and point-and-click shells for common system administration tasks.

Novell's involvement will get SVR4.2 into the company's authorized dealers, who will provide the added value of NetWare integration. Novell's dealers are an important channel, since it's largely the same one Microsoft is targeting with both LAN Manager and Windows NT. Novell is using SVR4.2 to get its share of the "open systems" pie and keep Microsoft out of Novell's stronghold.

Dataquest's Kirzner believes SVR4.2 will

What USL/Univel Promises with SVR4.2/UnixWare

- Compatibility with seven leading Unix implementations, including SunOS/Solaris, SVR3.2, BSD, and Xenix.

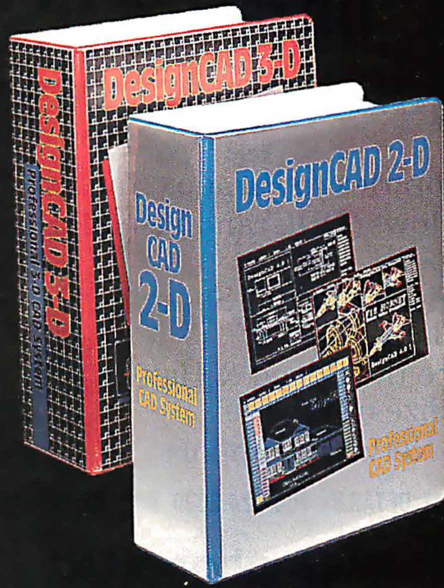
- Inclusion of the X Window System, with both OSF/Motif and Open Look interfaces, and development tools that allow users to switch applications' look-and-feel between them at run time. Adobe Type Manager will provide scalable fonts.

- Inclusion of TCP/IP networking in the base offering. UnixWare will offer NetWare capability as well, delivered by Portable NetWare.

- A minimum configuration of a 16-MHz 386SX with 4 MB of memory and a 60-MB hard drive.

- Graphical tools for common system administration functions, and a group of user productivity applications.

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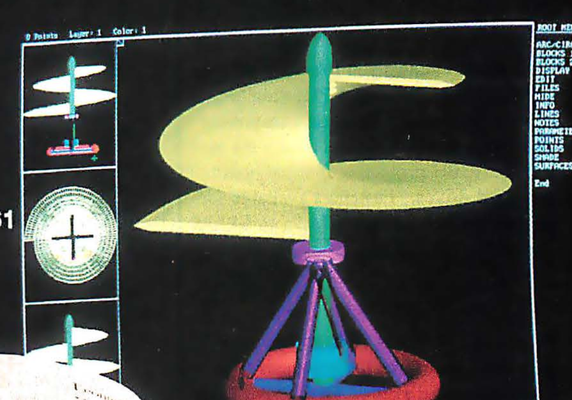


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allay the fears of some Unix vendors. "It's a pure, unadulterated version of B1-level secure Unix, but for the PC," she says. "You buy as much or as little as you need." Kirzner says SVR4.2 will be priced to compete against Windows and OS/2, ostensibly in the $100-to-$150 range. USL declines to give a price for SVR4.2, preferring to leave it up to its licensees.

Not everyone is convinced that SVR4.2 will be successful on Windows' and MS-DOS's turf. "It would be stupid to put Unix on people's desktops," says Andrew Toller, a principal with DMR Group, a Toronto market research and consulting firm. He notes that DMR consultants usually use Unix as a back-end system fronted by Windows on the desktop in all but the most technical environments, particularly in software development applications.

Open Systems Advisors' Lytton expects a rough beginning for SVR4.2. "[SVR4.2] is having the same honeymoon [as NT] right now with the press," she says. "But any major new release always has problems that need to be worked out." She cites MOOLIT (the Motif/Open Look Interface Toolkit) as an example, claiming that it won't support any application that uses superset features of Motif.

In spite of the doubts, Toller says that many DMR clients have begun asking about SVR4.2. "These are people that until a year ago didn't even know what Unix was," he says.

When SVR4.2 hits the streets, if it's everything that's promised, it will mark a new era in PC Unix. USL's doing the binary work will help ensure cross-platform application compatibility. USL is straddling the Open Look/Motif fence by offering both GUIs, and it's also committing to technologies like ANDF (Architecture-Neutral Distribution Format) and DCE (Distributed Computing Environment). DCE adds functionality to existing networks by allowing you to share applications as well as data. You can transparently allocate CPU power to networked applications, running pieces of a program on several machines at once.

The goal is to develop these and other new technologies at USL and then get them to packagers in a ready-to-run state, complete with documentation. That's a major shift for USL, and one that more closely parallels Microsoft's strategy than the arcane Unix channels of old.

It's Just Starting

Unix isn't dead, but certainly the next few years will mark a period of intense change. Users and developers will be faced with important decisions. As the Unix market consolidates, the query "Which Unix?" may change to a less confusing question: "Unix or NT?"

To answer that question, Unix vendors, previously content to focus purely on technical issues, will have to spend more time solving ease-of-use concerns. And they will have to counter Microsoft's marketing might head-on.

Unix has a rich history. If the new pack of Unix vendors can keep from bickering among themselves, Microsoft will face a strong competitor of NT. ■

Editor's note: *West Coast bureau chief Andy Reinhardt, news editor Patrick Waurzyniak, and senior technical editor at large Jon Udell also contributed to this story.*

Tom Yager is a BYTE technical editor and author of Unix Program Design and Development for IBM PCs *(Addison-Wesley, 1991). Ben Smith is a testing editor in the BYTE Lab and author of* UNIX Step-by-Step *(Howard W. Sams, 1990). You can reach them on BIX as "tyager" and "bensmith," respectively, and on the Internet at tyager@bytepb.byte.com and ben@bytepb.byte.com, respectively.*

The Greening of Computers

Both vendors and consumers are finding that environmentally sound computing pays

ANDY REINHARDT, ED PERRATORE, ANDY REDFERN, AND RICH MALLOY

In the computer industry, you never know where idealism leaves off and opportunism kicks in. The trend toward more environmentally sensitive, or *green*, computing offers the rare opportunity to indulge both simultaneously: A new wave of more ecological products and processes now emerging from research labs is making it possible for vendors and users to save money and save the earth.

The pleasant surprise is that for vendors, environmentalism is turning out to be smart business. Companies not only earn brownie points for being good citizens, but many of their new design, manufacturing, packaging, and waste recovery techniques also save money compared with older methods. When you factor in the constant need for vendors to differentiate their products in an overcrowded market, reengineering products and processes to be more ecological becomes too attractive a prospect to ignore. And if that's not enough, tough new laws in places like Germany and Sweden are forcing companies—including multinationals—to rethink how they make and package computer products.

The environmental impact of the computer industry is twofold: The use of computers generates both solid and toxic waste and represents a large portion of energy consumption in developed countries. The consumer typically pays the expense of dealing with the waste via costs that the manufacturer passes on and fees and taxes associated with municipal landfills. Electricity consumption of computers is a major hidden cost that many businesses don't bother to analyze.

Cleaning Up at the Factory

Compared to industries such as petrochemicals, metals, and paper, the computer industry once enjoyed a reputation for being relatively clean. The work of groups such as the Silicon Valley Toxics Coalition shattered this image by demonstrating that computer waste products (especially from semiconductor manufacturing) were polluting the air and contaminating soil and groundwater. According to director Ted Smith, the group is "now much more focused on ways to prevent pollution than on cleaning up what's already there." Companies are revising their processes to eliminate expensive chemicals and disposal charges.

CFCs (chlorofluorocarbons), used as a solvent to wash residue off printed circuit boards, are a main target for elimination. Although CFCs have been implicated in ozone damage for years, companies were slow to switch to alternatives because of the investment they had in using CFCs, and because alternative methods were comparatively more expensive. But in the wake of the 1989 Helsinki Declaration, in which 81

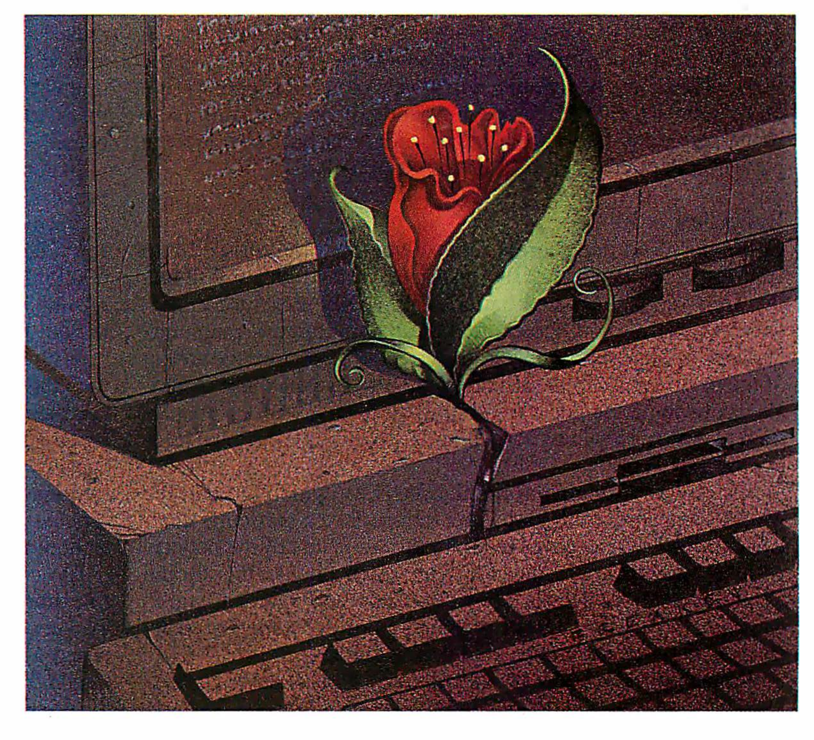


ILLUSTRATION: JOHN BREAKEY © 1992

countries committed to eliminate the use of CFCs by the year 2000, the cost of using CFCs, both politically and economically, has become too high to ignore.

In April 1991, Apple announced that it would use a new process for making boards and assemblies that does not require them to be cleaned. This change will let Apple eliminate all use of CFCs in its Fremont, California; Cork, Ireland; and Singapore plants by the end of this year. In June 1991, Compaq announced the adoption of a similar "no-clean" process, saying it would stop using all CFCs by 1995.

Other companies have dropped CFCs in favor of a remarkably simple cleaner: good old soap and water. At its manufacturing plant in San Jose, California, IBM now sprays its assemblies with soapy water, instead of bathing them in industrial solvents. Intel's systems plant in Oregon has made the same switch. According to Intel's spokesperson Howard High, the cost benefits are substantial: The company expects to save $1 million to $2 million per year on the cost to buy CFCs and an extra $1 million to $2 million per year it paid to dispose of the used chemicals. High says the costs of both raw materials and disposal are rising sharply, which will make the equation even more compelling in the future.

Ironically, while the substances used to replace CFCs may be benign for the ozone layer, some are dangerous in other ways. For example, U.K. chip manufacturer Inmos will be using IPA (isopropyl alcohol) as a replacement for CFCs. Unfortunately, IPA is highly flammable and would be extremely dangerous if used in the same quantities as CFCs. So, far from using a straight substitution, Inmos has had to find techniques for preventing accidental ignition of IPA and to develop a washing technique that reduces the quantity of fluid used. Fujitsu has developed an ultrasonic water cleaner. Using cold water, steam, and ultrasonic cleaning, Fujitsu says its device can remove 10 times as much dust as CFC washing did.

Another problem Intel and other chip makers confront is the disposal of defective parts. High says that Intel can reclaim precious metals from failed components if they're caught at the wafer stage. But once mounted in plastic or ceramic carriers, defective parts have to be tossed in landfills. High couldn't say how many parts Intel throws away each year but notes that the parts don't contain any hazardous compounds.

Large Computer Companies Eliminating CFCs

- **Apple**
- **Compaq**
- **DEC**
- **Fujitsu**
- **IBM**
- **Intel**

Recycling Is In

Computers and peripherals themselves are rarely tossed into landfills, but consumables, such as paper, printer ribbons, disk media, toner cartridges, and batteries, typically are. Such consequent waste from computers makes up a minority of municipal garbage, but its proportion has grown every year since the advent of the personal computer. Finding ways to recycle these materials has become the latest trend in the industry, with companies such as Apple, Hewlett-Packard, and Lexmark International leading the way.

Because environmental regulations vary widely around the world, companies with global operations face a particular challenge. Some have decided to adopt the standards of the country with the strictest laws, since those are often a bellwether for the rest of the world (see the text box "Tough Laws Promote Change" on page 150). Doing so lets companies enjoy economies of scale, since a single model can be sold in any market.

Waste disposal is really two separate problems: volume and toxicity. The amount of garbage directly due to computers is nearly impossible to determine, and awareness of the link is so recent that even the Solid Waste Association of America, an industry group that is part of the Society of Plastics Industry, can't quantify its magnitude. Some of the materials thrown into dumps (e.g., batteries and monitors) contain toxic chemicals that can leach out and poison the soil and groundwater.

Printers and Monitors

In the last year, several companies have announced programs to recycle laser-printer toner cartridges. BIS Strategic Decisions says that 11.75 million toner cartridges were shipped in 1990, projecting that the number will climb to 19 million this year and nearly 28 million in 1995. This is a lot of nonbiodegradable garbage to add to the world's landfills.

Apple's program to recycle toner cartridges began in March 1991. Cartridges bought in the U.S. include a prepaid shipping label that lets you return them when they're spent. For every cartridge you return in the U.S., Apple will donate $1 to one of two environmental organizations. Apple claims that 95 percent of the cartridge is recovered, and some of it is reused as is or recycled. Lexmark International, the IBM spin-off company that sells laser printers and typewriters, introduced a similar program last June. Ken Bissel, a Lexmark spokesperson, couldn't specify exactly how many cartridges were returned under the program but said that the number was relatively small but growing.

A booming business exists for remanufactured toner cartridges. At one time, "recharging" cartridges simply meant drilling a hole and putting new toner in. Now, says William E. Kelley, executive director of the International Cartridge Recyclers Association, cartridge remanufacturers "have learned that they have got to put out quality products." Cartridges are completely disassembled and rebuilt with new components as necessary. Some vendors replace the original drum with a lifelong unit, which can be reused several times. Remanufactured cartridges are less expensive. If a new cartridge cost $100, says Kelley, a remanufactured unit with a lifelong drum would cost about $75. And the vendor might give you a break on the price if you turn in that unit again because of the lifelong drum.

In Japan, Canon has its own recycling program. It is in the process of doubling the capacity of its reprocessing plant in China by the end of 1993. This facility currently recycles 150,000 cartridges per month. Canon expects to be able to reprocess 600,000 units by the end of 1994. The firm says it has been reusing almost 95 percent of the cartridges, which are collected in both Japan and the U.S.

With its new Ecosys printer, Kyocera has probably come up with the best way to deal with printer drums. One of Kyocera's key themes is to emphasize environmentally sound products and processes. To that end, the company has doubled its production capacity of polycrystalline solar cells, expanded the use of environment-friendly ceramics in industrial processes, and focused significant research efforts on thin-film technology. This thin-film technology is a key ingredient in Kyocera's new printer.

Kyocera used its thin-film expertise to create a photosensitive drum that is coated with a hard layer of amorphous silicon. To keep the drum surface clean, Kyocera supplies a ceramic-based toner, which is packaged in a biodegradable container (made from kelp). The result is that the drum will probably last the printer's lifetime, and all disposables are biodegradable. This

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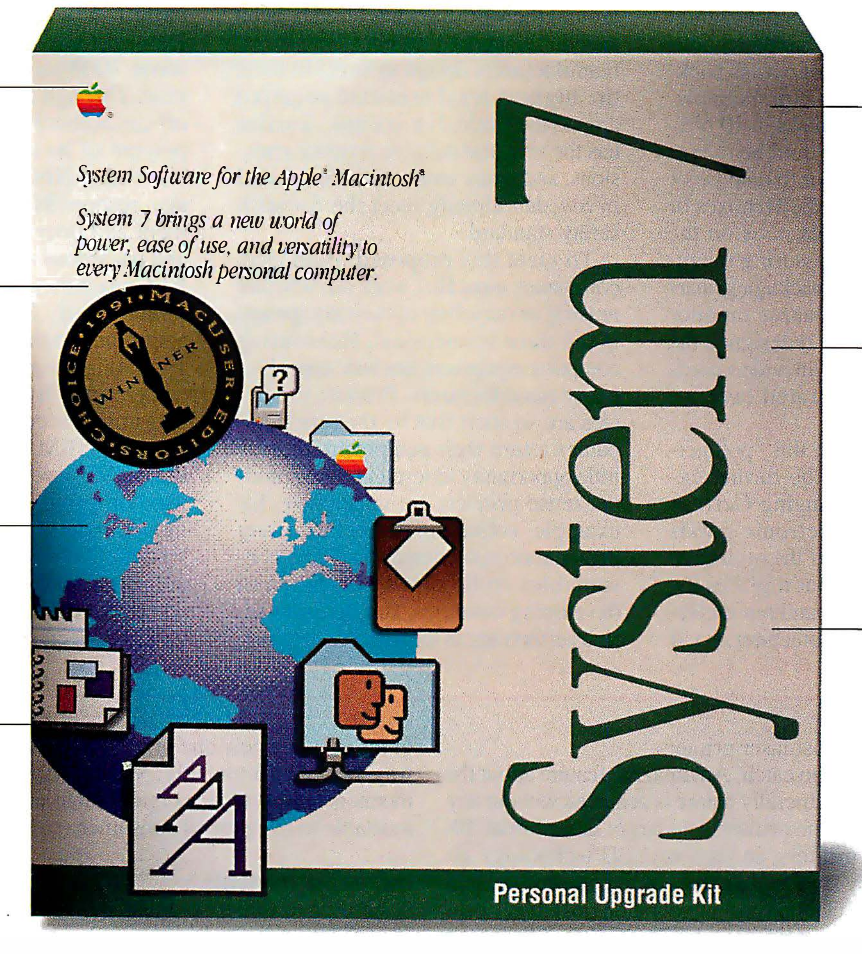
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Tough Laws Promote Change

ANDY REDFERN

The severity of waste disposal and energy conservation problems varies greatly around the world. Some countries, particularly those with high energy costs and relatively few means to discard trash, have taken legislative action to force companies to minimize these problems.

One key area affected is packaging. German law now places some responsibility for the disposal of excess packaging on the retailer. If, for example, you bought 100 floppy disks in 10 boxes of 10 disks each, it would be the responsibility of the retailer to dispose of the packaging that held the 10 boxes of disks together. With this onus on the retailer, retailers are pressuring manufacturers to use product packaging sparingly. For example, Japanese monitor maker Eizo has recently redesigned the four-layer packaging of its video cards so that only one integrated layer of packaging is left.

By the end of the year, this "polluter-pays" attitude is set to be further extended when a wide-ranging German state ordinance on electronic goods takes effect. The detail of the ordinance has still to be ratified, but it places the responsibility to recycle and reuse electronic goods on the manufacturer. So, if you buy a personal computer, once it has reached the end of its working life, you will have the right to return it to the manufacturer via the retailer. The manufacturer will then be legally obliged to recycle or reuse the system.

If this measure is ratified, it will have a major impact on computer design around the world. As has already been seen in the area of monitor emissions, manufacturers design systems to meet the highest legal standard required around the world. For example, Sweden has the toughest rules on monitor emissions, and many monitors not even sold in Sweden already meet the Swedish safety standards.

To meet this proposed ordinance, companies must first work out whether reusing or recycling of their equipment is the most economical. Renovating computer equipment has little appeal for many manufacturers. Product life cycles are so short that by the time companies return their equipment, there is little opportunity to resell it. Some product reuse projects are under way; for example, collecting and refurbishing personal computer equipment and consumables to be sent to charities in developing countries. But the most serious efforts are in the area of recycling.

Manufacturing giant NEC has been investigating the recycling of electronic equipment since 1969. Because of the use of expensive metals (e.g., gold) in high-performance systems, NEC has been reclaiming the precious metals from defunct systems for resale. NEC now has a partly owned subsidiary called Kowa Enterprises based in Kawaski City, Japan, that recycles some 3000 tons of machinery every year. Through a network of 52 branch offices across Japan, Kowa collects 90 percent of its hardware for recycling from other NEC subsidiaries. Kowa is also responsible for the safe management and disposal of industrial waste and hazardous substances from the old NEC machines.

In the early 1970s, IBM established a similar program in the U.K., and in 1991, this program recycled or reused 80 percent of IBM's total obsolete-parts inventory, according to reports published by IBM. IBM's goal is to raise this to 95 percent of all components used on printed circuit boards and in monitors. IBM has also voluntarily extended this recycling program by providing a disposal service for customers who have equipment that has reached its life expectancy.

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is in marked contrast to most laser printers.

The catch is that there is no catch. An amazing feature about the Ecosys printer is that its eco-friendly nature is achieved without any disagreeable side effects. The printer is no larger than similar 10-page-per-minute laser printers; in fact, its LED technology allows it to be considerably smaller than most of its competitors. And its price tag of $2395 and claimed cost of operation (less than 1 cent per page) are so low that even people who don't give a hoot about the environment should seriously consider this printer. The *Eco* in Ecosys could well stand for economy, as well as ecology.

Old or broken monitors can be disassembled for scrap, except for the CRT, which has to be disposed of in an expensive hazardous waste dump because of the lead in the glass. Monitors can also be reconditioned for less cost than buying new ones. Video Display (Tucker, GA) specializes in repairing CRTs in computer displays. According to company chairperson Ron Ordway, the most common point of failure in displays is not the tube itself but the electron gun or the electronics that drive it. Video Display can fix these components and preserve the rest of the tube and housing. The result is a refurbished monochrome CRT for about 60 percent of the cost of a new one or a color tube for about 50 percent, Ordway says. Unfortunately, Video Display sells its reconditioned monitors only to service organizations and repair shops; they are not available to the general consumer.

Salvaging Systems

According to Ethan Seidman, a researcher for *Garbage* (an environmentally oriented magazine based in Gloucester, MA), when a computer enters the waste-processing stream, it is usually stripped of all salvageable or recyclable parts, which can include metal or plastic casings, electronic components, wiring, and even nuts and bolts. Virtually nothing is left when the crows are done picking.

Some channels have emerged for disposing of intact but unwanted equipment. The East-West Development Foundation (Cambridge, MA) accepts donations of used systems for export to Russia and eastern Europe. Some companies sell their used equipment to brokers, who recondition it for export to the Third World. And the Solid Waste Association of America's information hotline (see the text box "Guide to Green Computing Groups, Products, and Services" on page 158) advises callers to donate old

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equipment to charities willing to accept it or to contact the manufacturer to see if it wants to reclaim the system for service parts.

The problem of dealing with obsolete equipment has led to changes in system design. Examples are the new expandable PCs from Compaq, AST, Acer, and others: Originally created to address an economical problem—the rapid obsolescence of technology and desire by customers to expand their systems—these PCs are also more environmentally sensitive because they delay the disposal of otherwise functional equipment. Similarly, many vendors are now redesigning their systems for ease of service, which also makes them easier and less expensive for salvagers to disassemble.

Some of the plastic computer cases are impregnated with leaded and cadmium pigments, but so far the evidence of leaching is inconclusive. A report in *Appliance Manufacturer*, May 1992, says that Europe, but not the U.S., has established a timetable for eliminating cadmium from some resins, including those often used in computer casings. HP has already decided to switch to resins that contain no heavy metals.

Companies are increasingly trying to ship documentation on CD-ROM.

The disposal of plastics, while much in the public eye, may become less of a problem as new techniques emerge for recycling plastic. This year, a study presented by researchers from Dow Plastics in Midland, Michigan, showed that the plastic (i.e., polycarbonate/acrylonitrile butadiene styrene) most often used in computer casings could be ground up and remolded with little or no degradation in key attributes, such as weight, thermal properties, and flame resistance; however, the color darkened slightly with each successive recycling.

These findings were achieved in a controlled environment using homogeneous plastic samples. The results were not as successful when different grades of plastic, or even similar plastics from different suppliers, were intermixed, suggesting that recycling will only be feasible when plastics are carefully sorted. To help promote that end, the Partnership for Plastics Progress, a group of 26 major resin producers, has recently started a committee called the Computers and Business Equipment Group. The group's charter is to focus on postconsumer issues, especially the disposal and recycling of plastics used in data-processing equipment.

The Paper Chase

Far from creating the paperless office, the microcomputer industry has contributed to even greater paper use. The American Paper Institute, an industry association, reports that shipments of uncoated, free-sheet paper grew from 6.5 million tons in 1976—the year the Apple II was introduced—to 11.5 million tons in 1990, the latest year for which figures are available. Ron Lamb, a spokesperson for the Council on Plastics and Packaging in the Environment, notes that the rise is due mostly to the advent of high-speed photocopiers, personal copiers, and laser printers.

Some of the surge in consumption is on the production side. For example, the Microsoft Windows 3.0 package, including documentation, consumed more than 2 pounds of virgin paper, which means that the 10 million units sold have alone used at least 21 million pounds of new paper. Microsoft, IBM, Sun, Apple, and other companies are aware of this problem and are increasingly trying to ship documentation on CD-ROM. Doing so not only saves trees but also substantially reduces postage costs and improves ease of use for customers.

A study conducted by Franklin Associates for the U.S. Conference of Mayors' National Office Paper Recycling Project found that in 1990, nearly 11 million tons of waste paper were generated in U.S. offices, of which the lion's share, some 8.1 million tons, is high-grade printing and typing paper. Another 1.2 tons is cardboard. These amounts are expected to climb to 9.2 million and 1.5 million tons, respectively, by 1995.

Only 15 percent of office paper waste was recovered for recycling in 1990, the study found. But with aggressive, coordinated efforts by business and government, the rate of recycling could be nearly tripled, for a total of about 3.4 million tons, according to the study. In addition to supplying the growing demand for recycled paper, this would reduce total office waste to 5.8 million tons, or about 70 percent of current levels.

The value of used paper depends not only on the stock but also on how it was used. In general, mixed paper has the least value and white ledger paper the most. But interestingly, plain paper that has been through an impact printer is four to 10 times more valuable than laser-printed paper waste, says Brian Day of the National Office Paper Recycling Project. This is because paper recyclers can't remove laser ink as easily, but new processes to de-ink the 60 percent of office paper now laser printed are on the horizon.

Battery Blight

The most notorious toxic waste from computers comes from their lowly batteries, which contain heavy metals, such as lead, cadmium, and mercury. Most desktop PCs today use a battery to back up system-setup memory, and nearly all battery-powered portables and notebooks use rechargeable nickel-cadmium batteries for system power.

Researchers from the University of Arizona Garbage Project, who have excavated 11 landfills in the U.S. and Canada to learn what they reveal about waste-disposal patterns, say batteries represent only two-tenths of a percent of the garbage by volume but alone constitute nearly 20 percent of the hazardous waste generated by U.S. households and offices. According to Marge Franklin of Franklin Associates, the main source of toxic cadmium is rechargeable batteries used in electronic devices.

Sometimes a nickel-cadmium battery is not really worn out but simply unable to hold a charge due to poor maintenance. Nickel-cadmium batteries exhibit what is known as the *memory effect*, where premature recharging can reduce battery life. According to Andrew Czernek of The Complete Portable (Prospect Heights, IL), nickel-cadmium batteries are good for 300 to 500 recharges before you must throw them out. For $39, the company will test your battery and restore it to full capacity through a series of deep discharges over a five-day period. If the battery is not recoverable, there is no fee. The Complete Portable disposes of bad batteries through recyclers. Some companies send Czernek hundreds of batteries at a time, saving the companies a considerable amount over the cost of new batteries.

In October 1991, Apple announced a battery recovery program for its PowerBook notebooks. Noting that rechargeable batteries typically expire after two years, Apple said it would accept used batteries at any of its worldwide service providers and pay the full cost of their recycling or proper disposal.

The long-term solution for system makers is to use newer battery types that don't contain cadmium, such as nickel metal hydride or zinc-air. Both of these emerging technologies offer an additional benefit: They have higher power-to-weight ratios than nickel cadmium does, which means you get longer operating life per pound of battery. Nickel-hydride batteries typically allow

notebooks to run about 25 percent longer between charges than would a nickel-cadmium battery of the same weight.

Makers of desktop computers are also addressing the battery disposal problem, while at the same time making their systems more secure and flexible. Both HP and Amkly Systems have eliminated battery-backed-up CMOS RAM for storing system setup information in favor of flash memory. With flash memory, there is no danger that the setup will be lost if the battery dies, and in both companies' PCs, the system BIOS is also stored in flash memory so that you can update it.

Save Power, Save Money

At its office in Munich, Germany, Intel has a guard, who, after hours, twice makes his way into every office and turns off unused PCs. Systems that must remain on (e.g., file servers or computers used for remote log-in) sport a prominent sticker—available from supervisors alone—that tell the guard to keep his distance.

Sound excessive? Expensive? When it comes to paying for power, Intel is like any other company that faces rising utility bills owing to the proliferation of computers and related equipment. Intel has found that the cost savings in power that this practice achieves have more than paid the guard's salary.

Studies on the energy required to run your business have been available for years. Items broken down have typically included things like manufacturing, air conditioning, and lighting. But until recently, studies have relegated the rising costs of computer equipment, as well as the extra cooling of office spaces using it, into the category of "Miscellaneous" or "Other." Steve Blanc, R&D program manager for Pacific Gas and Electric (San Francisco, CA), said, "This is the biggest unregulated load in any building. This load, particularly PCs, has increased on an order of magnitude."

According to nameplate-rating estimates by BR Associates of the power used by electronic office equipment in the Pacific Northwest, PCs alone accounted for 12 percent of the total. This figure does not take into account the increased expansion capabilities per PC since the 1986 study was done. Hard drives are bigger, CRTs use more power, and many networks have downsized to raise the percentage of power you can attribute to PC use. It can no longer be ignored. One San Francisco–based company, for instance, saved nothing after paying big for sophisticated control mechanisms designed to lower the company's energy costs a fat 20 percent. The culprit: the simultaneous rise of the number of PCs purchased and unaccounted for along the way.

Typical Per-Office Drain

Jeff Harris, a staff scientist for Lawrence Berkeley Labs (Berkeley, CA) explained a typical power scenario using the example of his own temporary work area at the U.S. Department of Energy. His PS/2 with a VGA monitor and expansion cards consumes 150 watts, and his laser printer uses about 250 W on average. He estimated power consumption at nearly 1½ W per square foot of office space. Lighting, the known factor in interpreting utility bills, has traditionally required the same wattage.

An added cost of running computer equipment, the cooling of work areas ranging from one-person offices to big data centers, must also be addressed. Citibank tackled this issue head-on in a Wall Street building it uses primarily for nighttime order entry and cash management. In this facility, the company optimized its

HVAC (heating, ventilation, and air conditioning) system, since turning off the mainframe and the many busy workstations wasn't an option. The result: 10 percent fewer kilowatt-hours. A figure like this translates into thousands of dollars annually.

Frequently, however, companies must cut back on energy devoted to cooling simply because of the number of PCs running—they literally don't have enough power coming into the building to run all the computers and the air conditioning at the same time. As a result, these companies chill offices overnight when the PCs are off and let them warm up gradually throughout the workday.

Energy Efficiency in the Desktop

It has taken portable technology to show us how much savings in energy can eventually be achieved in desktops (see the figure). The need for portable computers to conserve energy has driven the development of LCDs, low-power storage devices, and 3.3-volt components. "I would be surprised if anyone is designing 5-V systems by the end of 1994," said Jim Reinhardt, manager of marketing and applications for Motorola's 68000 processor line. (Part of his reasoning is that the new 0.5-micron technology can only operate at voltages lower than 5 V.) A 3.3-V design not only reduces power requirements, but it also cuts down on the heat a system produces. This eliminates the need for a cooling fan and helps relieve the strain on air-conditioning systems.

Another portable feature that is migrating to the desktop is power management. The computer center at Lawrence Berkeley Labs notified other departments that for $50 per year, it would back up all data on their Macs' hard disks every night provided the users left the machines running. But when Harris calculated how much power a department of Macs expended overnight, he found it exceeded the price they were paying for the backups. "The answer wasn't that we shouldn't back up our data," Harris explained. "What these machines needed was a sleep mode—to sleep until they did the backup, then to go back to sleep."

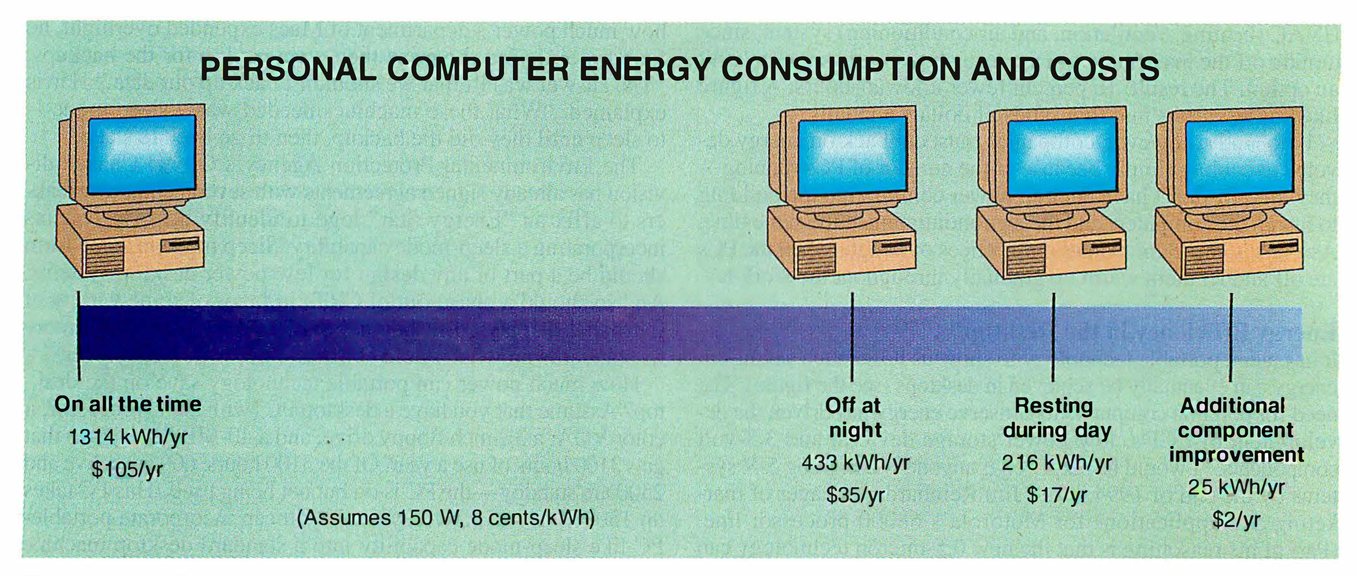
The Environmental Protection Agency's Global Change division has already signed agreements with several computer makers to affix an "Energy Star" logo to identify desktop systems incorporating a sleep-mode capability. Sleep mode in some form should be a part of any design for low-power desktop systems. And so should a phase-out of CRTs in favor of some variety of flat-panel displays. But beyond that, said Reinhardt, there are no standards on what would constitute a low-power system.

How much power can portable technology save on the desktop? Assume that you have a desktop PC (with a 386 processor, a color VGA, a 3½-inch floppy drive, and a 40-MB hard drive) that gets 3100 hours of use a year. Of the 3100 hours, 600 are active and 2500 are standby—the PC is on but not being used. This PC takes up 150 W, or 465 kWh a year. If you can incorporate portable-PC-like sleep-mode capability into a standard desktop machine (same configuration in high-power parts), you can bring the power consumption down to 153 kWh for a 67 percent savings per PC on your electric bill. In contrast, a similarly equipped laptop with an active-matrix color screen would use a mere 31 kWh per year.

Monitoring Monitors

Screen savers may do wonders for the phosphors in your monitor, but they do nothing for your electric bill. "The only point of keeping on a monitor is for someone to look at it," said Harris.

continued



The practice of leaving a personal computer running around the clock may have some marginal benefit for the system components, but it wreaks havoc on your electric bill. In large installations, energy costs could easily run thousands of dollars a year. Smart use of personal computers and the implementation of low-power components promise to dramatically lower energy requirements. (Data courtesy of EPA Energy Star Computers)

Some monitor vendors, mainly in response to government pressure in Europe and Asia, have introduced energy-saving monitors. Eizo, the Japanese monitor manufacturer known in the U.S. as Nanao, is leading the way. Its first energy-saving monitor, the F340i, is designed to power itself down when the PC doesn't transmit a signal. So, if you turn the system box off and forget to turn off the monitor, the monitor automatically switches off once it senses that the PC isn't sending a signal.

The F340i was launched last fall. Eizo is already working on a more sophisticated second-generation monitor that can recognize when a screen saver is active, so it can power itself down, too. Since Eizo develops video cards as well as monitors, it would not be difficult to develop a card/monitor pair that, through the use of a software driver, exhibited this property. But Eizo is looking for a more general solution. By using a custom Windows screen driver, Eizo claims it will be able to generate a unique output signal from any video card that the power-saving monitor will recognize. Then when the screen saver kicks in, the signal will be sent, and the monitor will power down, saving the screen and power.

Printing Smarter and Cheaper

The so-called paperless office, even on a relative scale, is another potential energy cost-cutter. "We need to ask, 'Do we really need all the faxing and printing we do?'" said Lawrence Berkeley Labs' Harris. E-mail, the strategic use of LANs for messaging and announcements, can greatly eliminate some of the power draw of these devices. Les Norford, an assistant professor of building technology at MIT's department of architecture, notes a common practice that is also an energy saver: sharing printers (particularly lasers), desktop scanners, and other peripherals.

If you're shopping for a printer, consider that ink-jet printers, while slower than lasers, use much less power—according to a 1990 study by Competitek (a research arm of the Rocky Mountain Institute), 80 percent less in standby energy and 97 percent to 99 percent less in printing energy. What about nonimpact printers already in service? You can dig into the manual for information on setting a quiet or power management mode, which uses less power on standby but takes an extra instant to come up to speed. "Printer companies," said Harris, "told me this feature is always disabled when the unit is sold." If it weren't, they explained, the printer would score poorly on computer magazine tests of the time spent printing a single page.

Computer Companies with Recycling Programs

- Apple
- Canon
- Hewlett-Packard
- IBM
- Intel
- Lexmark International
- NEC

The Industry Responds

Fortunately, the computer industry has begun to hear what utilities, major users of energy, and researchers are telling them. A major task force comprising the Department of Energy, the EPA, the Electric Power Research Institute, and several utilities met June 17–18 for the first time with representatives of all the big computer makers. "This is the first significant effort to bring together this group with the computer industry," said MIT's Norford. Vendor members include Zenith Data Systems, NCR, Apple, Smith Corona, IBM, HP, Compaq, and DEC. Each of these companies has said it will introduce energy-efficient models within a year.

The coalition's initial goals are to agree on and publicize a list of equipment features that are desirable from an energy standpoint and to come up with a test procedure for equipment purchases that would calculate the lifetime cost of running computers and related equipment. The American Society of Testing and Materials has long had a test for photocopiers' various modes of power usage, and this may serve as a model. Once test procedures become standardized and computer vendors reveal test data in product labeling, it should be far easier to make volume purchases with some confidence of forecasted increases in your company's utility expense.

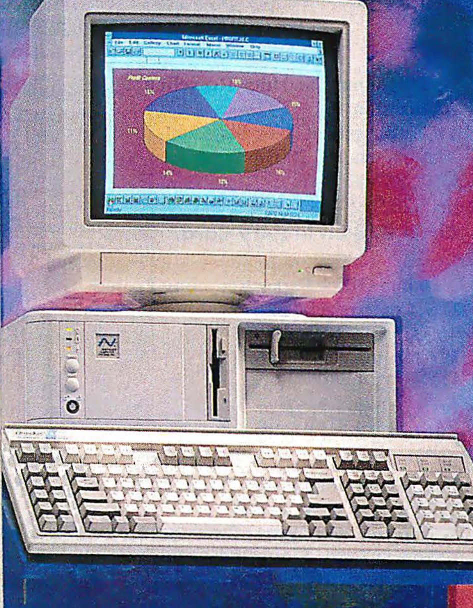
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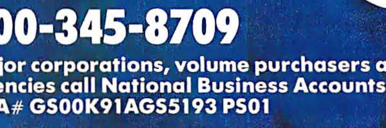
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U.S. Conference of Mayors
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fax: (202) 293-2352
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Partnership for Plastics Progress
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Washington, DC 20005
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fax: (202) 371-5679
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Silicon Valley Toxics Coalition/ Campaign for Responsible Technology
760 North First St.
San Jose, CA 95112
(408) 287-6707
fax: (408) 998-2642
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1868 Tucker Industrial Dr.
Tucker, GA 30084
(800) 241-5005
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ask them to see if they can shut down any unused equipment to avoid possible brownouts. HVAC systems at these companies are usually already automated. Lighting fixtures, an easy target for energy savings, have often been retrofitted throughout a company's facilities. What's left? The equipment that people use to keep their businesses alive: computers, which until recently were lumped under the "Other" category. "We need to break out of that 'Other' category," said Harris.

Ethics or Edge?

Is "environmental sensitivity" merely this year's marketing catchphrase? Or do the programs outlined above represent a real shift in the computer industry toward protecting the earth? The answer is somewhere in the middle.

Many of the companies whose programs now lead the way in green computing have long had public commitments to environmentalism. Other companies are merely jumping on the bandwagon because it is advantageous from a financial or marketing standpoint. But whatever the motives, the small changes in expectations and practices that these companies are now instigating could eventually add up to big economic savings. ■

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The Outlook for Pen Computing

Pen-based computing struggles with its problems but looks to a bright future

NICHOLAS BARAN

Jimmy Cliff's hit from the 1970s, "Many Rivers to Cross," could well be the theme song of pen-based computing. Despite early systems such as the GridPad, the pen-based industry first received major attention in January 1991: Go Corp. announced its PenPoint operating system, and Microsoft acknowledged Windows for Pen Computing. Although it's received a great deal of hype over the past year and a half, pen-based computing must overcome major technical and market challenges before it lives up to the expectations of potential users.

Both PenPoint and Windows for Pen Computing began shipping in April. The first pen-based systems that support these interfaces are too heavy, too expensive, and too hard to read. Also, they run at best for 3 hours on batteries. (See "Rough Gems: First Pen Systems Show Promise, Lack Refinement," April BYTE.) On the software side, most applications are still in the beta stage, and handwriting recognition is only marginally acceptable.

Nevertheless, pen-based computing represents the most exciting and promising area of computing to come along since the desktop personal computer. Desktop computers have reached a degree of maturity in which most new development represents refinements to the existing technology. Pen-based computers, on the other hand, represent an arena ripe for major technical breakthroughs.

The High Road and the Low Road

The young pen-based computing market can be divided into two categories: the high end and the low end. On the low end, DOS-based systems using the 8086 or NEC V20 architecture prevail. The most popular of these systems is the GridPad from Grid Systems (Fremont, CA), which was one of the first companies to enter the pen-based computer market. Grid offers an interface layer called PenWrite and a set of development tools called PenRight for developing forms-based applications running on DOS. Fujitsu Personal Systems (Santa Clara, CA), formerly Poqet Computer, has introduced a V20-based system, called the PoqetPad, which supports Grid's PenRight development environment.

The driving concept behind machines like the GridPad and the PoqetPad is to provide a no-frills system for data entry and retrieval using custom forms—no GUI, no multitasking, but enough power to run a basic forms-based application with limited handwriting recognition. These systems are well designed for that purpose. Grid's recently announced PalmPad straps to your wrist and weighs less than 3 pounds. It has a

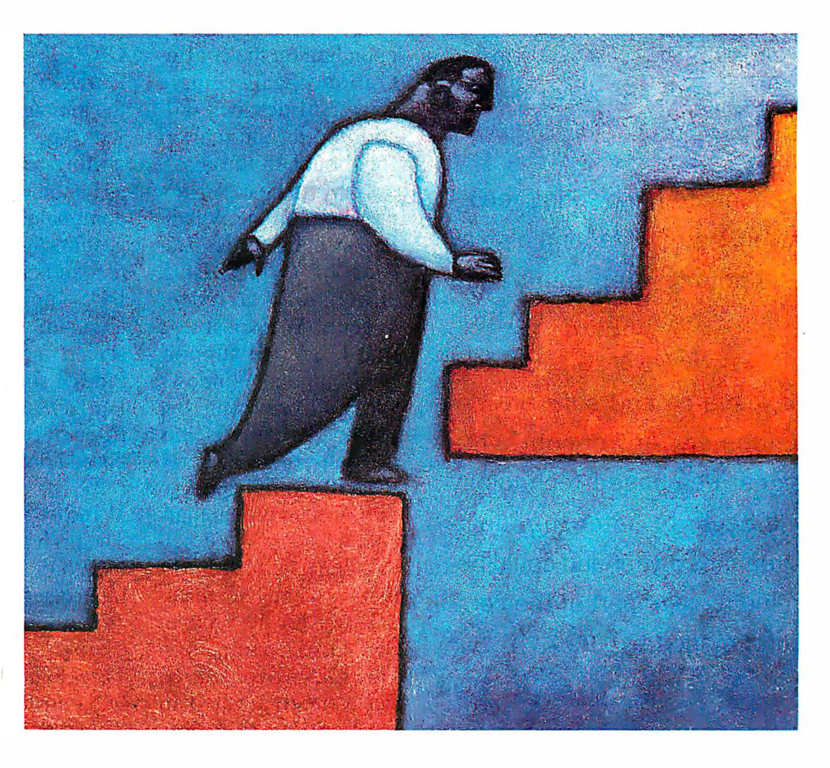


ILLUSTRATION: TED PITTS © 1992

detachable battery pack that you wear on your belt.

This type of system may be all that's required for many pen-based applications, particularly in vertical markets. For example, Detroit Edison recently purchased over 300 GridPads for use in filling out work orders and time cards in the field.

To make things more interesting, GeoWorks (Berkeley, CA) has announced a version of its PC/GEOS graphical operating environment for pen-based systems, called Pen/GEOS. Pen/GEOS is targeted toward 8086- and V20-based systems and provides a GUI. Jeff Hawkins, a former Grid vice president, founded Palm Systems (Menlo Park, CA) to develop handwriting-recognition software and other applications for Pen/GEOS. Pen/GEOS should start appearing on systems like the PoqetPad by early next year.

Tandy (Fort Worth, TX) and Casio Computer (Tokyo, Japan) recently announced that they are jointly developing a family of pen-based "personal information processors." GeoWorks and Palm Computing are providing the operating system and handwriting-recognition software, respectively. Tandy would give no introduction date as of this writing, however.

Hawkins, who developed the handwriting-recognition engine used on the GridPad, says that Pen/GEOS will be "a key part of the palmtop market." He's impressed with the truly object-oriented environment of Pen/GEOS and its ability to support multitasking. Hawkins says he can run several applications simultaneously on an 8088 with 512 KB.

In the near term, systems like the GridPad will be very attractive to users who need to get a basic job done. You can expect to see hand-held devices sporting the Pen/GEOS interface next year, according to Hawkins. Chips & Technologies, a Santa Clara chip vendor, joined GeoWorks at the introduction of Pen/GEOS, promoting its single-chip PC architecture as an ideal match for Pen/GEOS. Chips & Technologies plans to sell this strategy to OEMs.

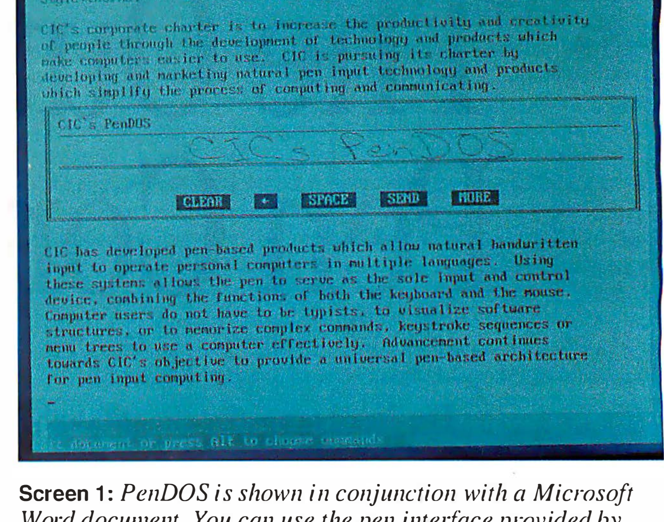
The question remains, however, if the 8086 architecture can hold its own against more powerful processors, such as the processor based on the ARM (Advanced RISC machine), which will appear in Apple's Newton and other hand-held devices (see "The PC Gets More Personal," July BYTE). Considering the processors used, the GridPad and PoqetPad systems are not inexpensive: They cost $2000 to $3000, depending on the configuration. Smaller, more powerful devices will soon be on the market for about half the cost.

Nevertheless, Grid's president, Bruce Walter, is confident in the success of Grid's DOS strategy. In a recent speech, Walter stated that Grid will support PenPoint and Windows for Pen Computing, but said, "PenWrite has proven to be exactly what the forms-application-based vertical markets want."

Doug Gauthier, information management supervisor for the Human Services Department in Phoenix, Arizona, used PenWrite to develop an application that lets caseworkers record client information. When his project began, Grid was really the only choice. Gauthier was able to do all development on existing 286-based PCs. He has had such good success with PenWrite that he would not consider switching, unless compelling applications were available on other platforms (e.g., Lotus 1-2-3). Gauthier's application consists of 40 on-line forms up to 16 or 17 pages long. The 200-KB executable file "fully utilizes" the GridPad's capabilities, Gauthier said.

BYTE ACTION SUMMARY

Inadequate handwriting recognition, battery life, and display technology keep pen-based computing mired in vertical niches. However, a great deal of research and software development are encouraging signs. Pen-based technology will begin to enter the mainstream next year and could become a major part of the computer market by 1994.



Screen 1: *PenDOS is shown in conjunction with a Microsoft Word document. You can use the pen interface provided by PenDOS to edit the document, using handwritten text for insertion or cutting and pasting. PenDOS commands appear in the upper right corner of the screen.*

Fitting somewhere between the low end and the high end is the PenDOS operating environment from Communication Intelligence Corp. (Redwood Shores, CA). It is on the low end in the sense that it runs as a layer on top of DOS. PenDOS is on the high end because it requires a 386 processor (primarily because of CIC's handwriting-recognition engine, which is bundled with PenDOS). According to CIC's marketing engineer Bruce Leong, the main goal of PenDOS is to enable DOS applications to work with a pen-based interface and to take advantage of CIC's handwriting-recognition technology.

PenDOS lets you use a pen and handwriting to execute DOS commands and to run DOS applications. It provides a set of pen gestures for performing operations such as inserting and deleting text and cutting and pasting. These gestures will work with any DOS application that supports a mouse without modification. You simply point with the pen at the upper right corner of the screen to activate the PenDOS interface (see screen 1). CIC provides a software development kit for developers who are using PenDOS. PenDOS is likely to gain some support in the marketplace. It offers a straightforward solution for developing forms-based applications with handwriting recognition on top of DOS.

Windows for Pen Computing and PenPoint

The high end is dominated by Windows for Pen Computing and PenPoint. Both operating environments require 386 systems or higher, a minimum of 4 MB of RAM (Go recommends 8 MB), and at least 20 MB of mass storage, although 40 MB is more realistic. A recent demonstration of PenPoint using an IBM ThinkPad with 20 MB of storage was barely adequate. The system constantly swapped applications from disk. Both systems offer full-featured GUIs with multiple fonts and handwriting

recognition. However, Windows for Pen Computing and PenPoint are very different environments, built from completely different foundations and concepts.

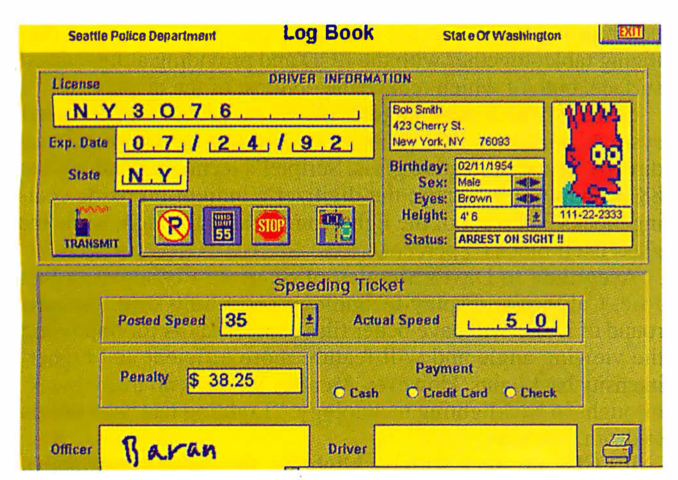
Windows for Pen Computing is simply an extension of the desktop, mouse-based version of Windows. Although it is an extension of a desktop interface, it handles pen input remarkably well (see "Windows Meets the Pen," June BYTE). For Windows users, Windows for Pen Computing offers a familiar interface with the pen replacing the mouse. It offers the added functions of handwriting and drawing with the pen.

In support of Windows for Pen Computing, Microsoft is promoting its Visual Basic programming toolkit as a platform for developing pen-based applications. I've been impressed with some of the initial demonstrations and prototypes of forms-based pen applications developed with Visual Basic. For example, Microsoft has developed a prototype of a traffic accident and citation report form application for police work using Visual Basic (see screen 2). The form lets the officer fill in the details of the accident or traffic violation (e.g., license numbers, speed, or a sketch of the accident scene).

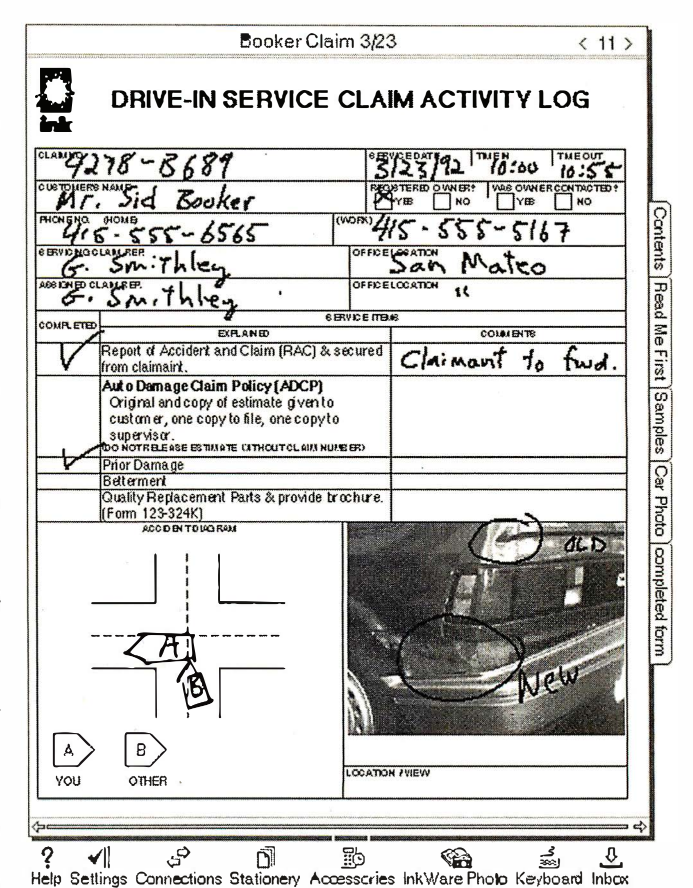
There is little question that Windows for Pen Computing will play a major role in the pen-based market. The sheer numbers of Windows users and applications developers virtually guarantee its success.

PenPoint, on the other hand, faces the formidable challenge of establishing itself as a new operating system and as the one of choice for pen-based computing users. From a technical standpoint, PenPoint has significant advantages over Windows for Pen Computing. I spent a week using both environments on an NCR 3125. As Go claims, PenPoint is a far more intuitive interface for pen computing than is Windows for Pen Computing. With PenPoint, the computer behaves much like a paper notebook (see screen 3). It has tabs on the side. It has page numbers. Each file appears as a document or page in the notebook and is automatically updated and stored.

PenPoint is a multitasking environment, so you can switch from page to page or document to document without thinking about closing files or waiting for applications to load. This lets you interact with the computer in a manner similar to working with a notebook; by tapping on the appropriate tab, the notebook "turns" to the correct page. You can concentrate on the work at hand rather than on details such as saving files.



Screen 2: *A screen from a Windows for Pen Computing prototype application developed using Visual Basic. The traffic accident and citation form lets you enter the details of the accident with the pen.*



Screen 3: *A screen from the Note Taker application running under PenPoint. The right edge of the screen shows the notebook-like tabs. PenPoint looks and behaves much like a paper notebook.*

Another feature that differentiates PenPoint from Windows for Pen Computing, and may be one of its most important advantages, is its automatic networking capability. PenPoint has a built-in version of the TOPS peer-to-peer network called PenTOPS from Sitka (Alameda, CA). Simply by tapping on the Connections icon and specifying that you want to establish a network connection, you can automatically connect to another node, by a wireless connection or by standard AppleTalk cabling. You can automatically detach from the network, and you can "defer" output for later connection to a network.

These features will be of major importance in the pen-based computing environment. For example, deferred output and automatic network connection will be an important feature for mobile workers who return to the home office at the end of the day to download data and to upload data for the next day's work.

But in spite of its technical elegance, PenPoint has a great deal to prove. Although PenPoint may be technically superior, Windows for Pen Computing works surprisingly well and will meet the needs of many pen users. Although it's easier to learn than Windows for Pen Computing, PenPoint still has idiosyncrasies and obscure functions that are not readily obvious. For example, I couldn't figure out how to change the names of the tabs on the side of the notebook page.

Another problem is the lack of PenPoint development tools, other than the Watcom C compiler. Windows for Pen Computing has a big advantage, with tools like Visual Basic and many others that are familiar to the software development community.

continued

But PenPoint development tools are a key priority for Go and will appear in the next year, according to Go's cofounder Robert Carr. In addition, Norm Francis, founder of PenMagic and developer of Numero for PenPoint, pointed out that all operating systems suffer from a lack of development tools in the early going. He added that for a new operating system, PenPoint is remarkably stable and robust.

In the final analysis, PenPoint is an impressive technical accomplishment that is just in its infancy. In the years ahead, PenPoint will appear on other processor architectures and will undergo many refinements and improvements. Although Go will not comment on its plans for porting PenPoint, it points out that PenPoint is written in C and designed to be portable. Reliable sources indicate that PenPoint will appear on AT&T's CRISP (C-machine Reduced Instruction Set Processor). PenPoint is likely to have a bright future.

Handwriting Recognition Must Be 100 Percent

Perhaps the biggest limitation that is common to both Windows for Pen Computing and PenPoint (and to environments such as PenDOS) is the current state of handwriting recognition. Both environments come with handwriting-recognition engines. And it is supposedly possible to substitute other vendors' engines. I've tried Microsoft's, Go's, CIC's, and Momenta's engines, and none of them offer 100 percent accuracy, even after you've trained these systems to better recognize your handwriting.

While it may seem like a harsh requirement, handwriting recognition must be *100 percent accurate* to be successful. It is simply not acceptable to worry about whether the machine recognized your last name correctly or got an *S* and a 5 mixed up. Nor is it acceptable to go back and overwrite an incorrect character, often several times before it gets it right. Users won't put up with it, especially when these systems cost $5000 or more.

The current technology is really aimed at filling in "small things, like names and addresses," according to Hawkins. He added that anybody who expects a computer to recognize a person's notes will be disappointed. Writing tends to get sloppy when people start dealing with sentences, and at that point the recognition engines start having problems. But Hawkins believes that handwriting recognition is not the real issue. He says that people will buy pen-based systems "because of the valuable things you can do with the pen interface."

Perhaps the key to more acceptable handwriting recognition is the development of cursive handwriting-recognition engines. Several companies are working on cursive recognition, including Paragraph International (a Russian firm that has offices in Moscow and Boulder, Colorado), Microsoft, CIC, Nestor (Providence, RI), and AT&T. While Paragraph has demonstrated its cursive recognition system, this technology still has a long way to go before it appears commercially. Both Apple and Microsoft have announced that they are licensing Paragraph's technology. Much of the research involves neural networks and DSPs (digital signal processors), which would require different hardware designs than those currently used on pen systems.

The process of cursive handwriting recognition requires that several complex algorithms be solved simultaneously. This includes so-called "feature extraction" and "segmentation" of various components of the cursive script, application of context-sensitivity to determine heuristically what characters most likely apply to the script, and then coordinating these processes to arrive at the recognized character. Neural networks provide the software intelligence, and DSPs provide the coordination and speed for responsive recognition. AT&T, Intel, and Motorola have been working on neural-network architectures intended for solving complex problems such as cursive handwriting recognition.

Third-Party Software

Most third-party pen-based applications are still under development. Any standard Windows application runs on Windows for Pen Computing but does not offer features designed for pen-based input (e.g., handwriting data-entry fields and check boxes).

There are promising products for both PenPoint and Windows for Pen Computing for forms entry, address book and Day-Timer scheduling, financial and spreadsheet modeling, drawing and note taking, and document reference and retrieval systems. For example, Slate (Scottsdale, AZ) is working on a product called PenBook, with versions for both environments. This product is designed for searching and browsing through large documents (e.g., parts or instruction manuals, dictionaries, or encyclopedias).

In the vertical-software arena, there is tremendous interest from the medical community. For example, Pi Systems is targeting its Infolio pen-based system toward the medical profession. Other vertical markets include insurance and real estate appraisal, delivery systems, building and railroad inspection, and more.

Pen-based computing presents a new arena for software developers and offers the opportunity for innovation that has virtually disappeared from the desktop arena. It's a chance for small companies to score a hit. We can expect to see some powerful and innovative applications in the next two years.

Hardware Is the Key

While the software has some rough edges, the real technical hurdles in pen-based computing are in the hardware. Current machines suffer from two related and serious limitations: limited battery life and inadequate readability. Display readability can be improved by backlighting, but backlighting consumes a lot of power. While hard drives and memory-storage devices are also substantial power consumers, displays represent the most power-hungry components, requiring from 3 to 5 watts.

Reflective displays, such as that on the NCR 3125, don't require backlighting. However, they simply don't provide enough contrast to be readable, except with excellent ambient lighting. Some newer LCDs boast a 12-to-1 contrast ratio, but backlit displays provide a minimum of 15 to 1.

Both reflective and backlit displays suffer from extremely limited viewing angles. Pen-based systems that I've seen require head-on viewing. Two people sitting side by side have difficulty with both seeing what's displayed on the screen. LCDs on laptops have improved dramatically in the last few years. But pen-based systems face the added complexity of layering a digitizing tablet together with the LCD and providing a ruggedized surface, both of which reduce the contrast of the display.

Scriptel, which manufactures digitizing tablets for pen-based systems, minimizes the problem by binding the digitizer layer directly on the protective glass. Scriptel's technology allows for 88 percent transparency; the digitizer's indium tin oxide coating blocks 3 percent of the light from passing through, while the glass itself blocks 9 percent.

According to David Mentley of Stanford Resources, a San Jose, California, display-technology consulting firm, the next round of LCDs will have better film compensators for improving the viewing angle and will feature more efficient and higher-intensity backlights. However, Mentley foresees no major breakthroughs in backlighting technology: "Lighting has been beaten to death," he says.

If LCDs are stuck with backlighting, the major improvement will have to occur in battery technology. Some promising developments are on the horizon. Zinc-air batteries were shown in a prototype pen-based system at a recent conference. They ran for up to 10 hours. However, no vendor has publicly committed to using zinc-air batteries, which are expected to cost up to four times

as much as nickel-cadmium batteries (see "Zinc-Air Batteries: Long May You Run," May BYTE, page 28).

Another component on current pen-based systems that contributes to higher power consumption, size, and weight is the hard drive. The 1.8-inch hard drives consume between 1 and 1.5 W of power during read/write operations. Hewlett-Packard's 1.3-inch Kittyhawk hard drive requires between 1.5 and 1.7 W. Flash-memory devices such as SunDisk's (Santa Clara, CA) SDI series have many advantages over hard drives, except that they cost about 10 times as much. Flash-memory devices are much more durable (500 gs of operating shock versus about 100 gs for the Kittyhawk), weigh less, and fit in a narrower space.

Flash-memory devices, however, cost about five times more per megabyte than the 1.8-inch hard drives and require at least 5 volts to operate. Small computing devices are moving toward 3.3-V designs to minimize power requirements.

Because of its convenience and durability, flash-memory storage will eventually be the choice for mass storage for pen-based systems. Prices must come down first. Intel has announced that it will offer a 20-MB flash card for about $600 in quantity pricing. This represents a drop of about $20 in cost per megabyte for flash memory.

Intel recently announced a 3.3-V version of its 386SL processor. This chip has what Intel calls a FlexibleVoltage feature, which allows system designers to build computers without reengineering their existing power management strategies. This low-power CPU, along with others from companies such as AMD, represent one more step toward reasonable battery life on pen-based systems.

The Crystal Ball

What people want in a pen-based system, says Hawkins, "is a very powerful device that weighs under a pound and costs under $500." Clearly, pen-based computing technology has a long way to go to meet that goal. Consider the evolution of the PC from 1982 to 1992—how much machines improved, and the relentless downward progression of the price/performance curve. A similar pattern of evolution is foreseeable with pen-based computing technology. By next year, you will see improved displays and batteries and considerably less expensive flash-memory devices. This trend will be more dramatic by 1994.

In 1993, you will also see more hand-held pen systems (e.g., Apple's Newton). Coupled with these new devices, you will see new processor architectures emerge in the pen market. Newton will use the ARM processor. AT&T's CRISP is expected to appear in pen-based systems from a company called Eo Computer (largely staffed by former Go engineers). PenPoint is likely to appear on the CRISP platform as the main operating system.

In conjunction with these developments, you can expect major advances in wireless networking. The FCC is expected to provide a dedicated frequency band for spread-spectrum wireless networks within the next two years, thus opening up the possibility for true wireless networking using pen-based systems (see "Wireless Networking," April BYTE).

Overall, the future looks bright for pen-based computing. But, as with the early days of the PC, users and customers will have to be patient. In the initial phases, only "early adopters" like large corporate accounts with specific problems to solve will buy pen-based systems. By 1994, you can expect pen-based systems to be affordable enough and to work well enough that the market will open up and start to take on the dimensions of the PC market. ■

Nicholas Baran is a consulting editor for BYTE and coeditor of Pen-Based Computing *(Sandpoint, ID). He can be reached on BIX as "nickbaran."*

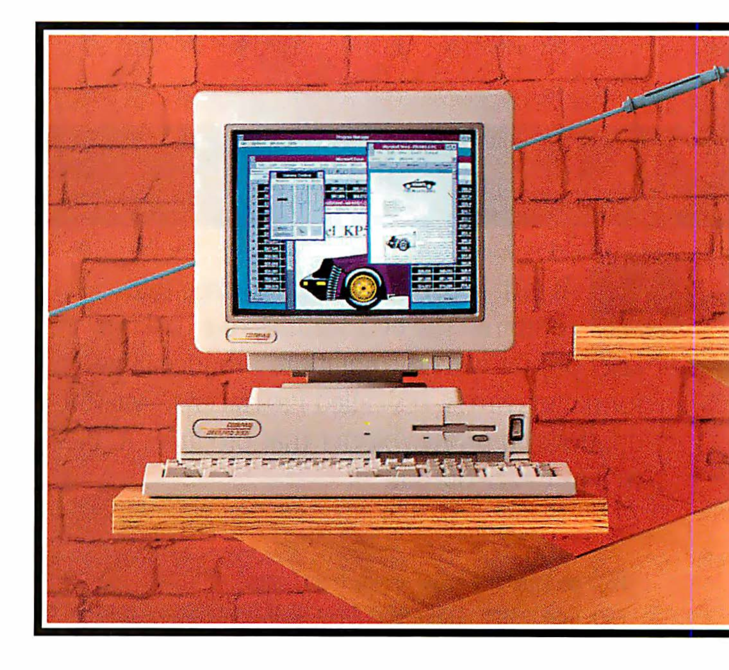
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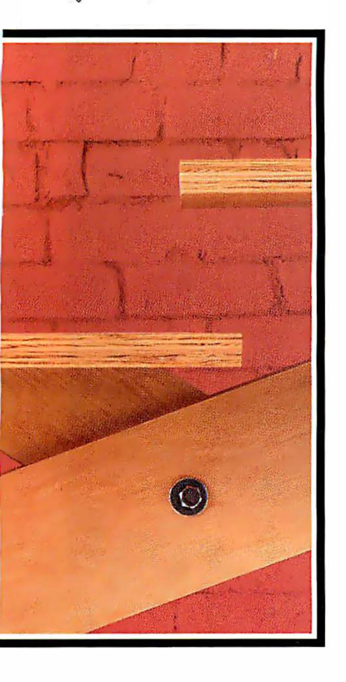
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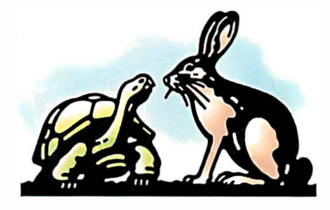
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PHOTONICS: REVOLUTION OR EVOLUTION?

Processing with light is poised to live up to its potential to help you compute faster and better

JACK WEBER

Revolutions never happen overnight—unless you're not expecting them. The wind of change that's now blowing through the silicon corridors and magnetic hallways of computing is bringing with it a profound shift in the ways people will process, store, and transmit data. Optical technologies are infiltrating what was once the exclusive preserve of electronics, introducing not just new devices or different data structures but a fundamental change in the physical fabric of information.

No one is suggesting that electronics will disappear or that its own evolution and growth are about to end. But optical and optoelectronic technologies will certainly rewrite the ground rules of the computing game.

Already we've seen the inexorable growth of optical storage. CD-ROM and WORM drives are commonplace and are being joined by new technologies, such as magneto-optical and phase-change drives. And optical techniques based on lasers and LEDs have virtually reshaped the printer market.

More significant than these new technologies is the rise of networking and remote access. Data communications through the telephone network could never have developed without the high bandwidth and low error rate provided by optical fibers. Optical LANs and WANs (wide-area networks) are bringing fiber to users' desks, and, for the first time, optical connections are starting to appear in individual computers.

The one area that hasn't yet succumbed to the revolution is the very heart of computing: the processing logic that manipulates data, and the memory that holds it ready for use. But even these are poised for change. OEICs, or optoelectronic ICs (see the glossary "Unbending Lightwave Terminology" on page 171), which combine both technologies, are starting to find their way into commercial machines while, in laboratories around the world, experimental all-optical processors and memories offer a glimpse of the future (see photo 1).

A research team headed by scientists at Conductus, Inc. (Sunnyvale, CA), is attempting to integrate optical technologies into a prototype computer designed to eventually bring supercomputing performance to desktop machines. This development will combine photonics with cooled semiconductor and advanced superconductor technologies to achieve performance said to be orders of magnitude greater than that of personal computers and workstations being used today.

The team that will develop the machine is composed of scientists from TRW Space Technology Group (Redondo Beach, CA), the University of California–Berkeley, NIST (National Institute of Standards and Technology) (Boulder, CO), Hewlett-Packard Research Division (Palo Alto, CA), and Stanford University (Palo Alto, CA).

It would be easy to perceive optical technology as a threat to silicon's status quo or as a panacea for all its problems. It is neither. The attraction is that it addresses precisely those problems that are emerging as limits in the electronic domain—problems like pin congestion on ICs, the tangle of tracks on printed circuit boards, signal skew, cross talk, pulse degradation, and electron tunneling. The list goes on and on, but all these problems—and their solutions—arise from a few fundamental properties of electricity and light.

Let There Be Light

Electronics is a technology that manipulates the flow of electrons. Photonics, a technology that is its optical equivalent,

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Light Switches
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Is What You See What You Get?
BY DAVID CASASENT
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Photo 1: *Polymer memory cubes such as these prototypes developed by UCI's Peter Rentzepis are capable of storing information in three dimensions. Data can be written and read in thousandths of a second by two laser beams. (Photo courtesy of University of California–Irvine)*

manipulates photons. The differences are simple but profound: Electrons have mass and an electric charge; photons have no mass and no charge—they are simply packets, or quanta, of electromagnetic energy.

As a result, electrons interact with each other through capacitive and inductive effects; photons do not interact at all. In addition, mobile electrons require energy proportional to the distance they travel—it's the cost of carrying an electric field around. Photons have no such baggage; they can travel across the universe with no more energy than they set out with.

The consequences for computing are that electrons are more easily controlled but slower and less efficient than photons. Their interactions produce cross talk between adjacent signal paths. Photons, on the other hand, can travel freely through open space, crossing other light beams with no effect. Because they have no mass, they can reach the maximum speed allowed by nature: the speed of light.

BYTE ACTION SUMMARY

Optical technologies already have had a profound effect on digital communications, data storage, and printing. One day, the computers you use will contain optical memories, optical interconnections, and even optoelectronic processors.

One of the most important measures of potential computing power is the energy required to transmit a bit of information. In this respect, light is efficient, but it requires more complex technology that is less developed than that of the electronic domain.

Those are the trade-offs, but electrons and photons also have something in common: They are both quantum phenomena. This means that if you look at them one way, they'll behave like particles, but if you look at them another way, they'll appear as waves. In electronics, this wave-particle duality can be ignored most of the time. Photonics, however, demands that engineers grasp and deal with quantum mechanics, because understanding and using the physics are central to many of the devices and systems of optical computing. The challenge is to fabricate the technology.

As in electronics, the devices required for optical processing must be capable of generating and detecting bits of information, transmitting them from one point to another, performing logical operations, and storing and retrieving data. The first and obvious requirement is a light generator, usually a laser or an LED. In these devices, as electrons pass through a semiconductor junction, they acquire sufficient energy to jump to an excited energy level. This is an unstable state for electrons, so they quickly jettison their extra energy in the form of photons and return to their stable ground state. In an LED, this process happens randomly. In a laser, the electrons fall back in step, and the light they produce is coherent (i.e., in a state in which all the photons have the same phase).

Solid-state lasers are relatively efficient and capable of switching at tens of gigahertz, which makes them a mainstay of high-bandwidth communications and processing. Until recently, the problems were their large physical size and their restricted range of wavelengths. Not anymore.

In 1989, Bellcore researchers produced the first microlasers, some of which measured only 1 micron across. Although the power of each laser is low, millions of lasers can be packed tightly together. Most important, they emit light perpendicular to the chip surface, a factor that will be essential for transmitting data directly from an IC.

The other problem diminished in 1991, when researchers from 3M Corporate Research Center (St. Paul, MN) broke the wavelength record and developed solid-state zinc selenide lasers emitting blue and blue-green light at wavelengths as short as 490 nanometers. Being able to produce these shorter wavelengths is important because they can be focused more tightly, allowing higher densities in optical storage and better resolution in laser printers.

Recently, scientists from the Defence Research Agency (Malvern, U.K.) made an exciting discovery: photoluminescence and electroluminescence in acid-etched silicon. Normally, only semiconductors like GaAs (gallium arsenide) can emit visible wavelengths, but they're not widely used in computers. So, this discovery of silicon light may be a crucial factor in bringing optoelectronics into the mainstream.

Generally, solid-state generators and photodiode detectors are well-established technologies, but optical processing will require more novel devices. What's needed is the ability to control light with light, just as transistors use one current to control another. But electrons interact with each other; photons don't. Thus, special materials, called *nonlinear optical materials*, are needed to mediate this action.

New Materials and Devices

Ordinary glass is linear because its optical properties are independent of the light level. Photochromic glass (e.g., that used in eyeglasses that darken in bright sunlight) is nonlinear, however: Light alters the glass's optical properties. A great many substances exhibit various nonlinear effects (e.g., as the light intensity changes, they alter their color, refractive index, opacity, or polarization), and new types of these materials are being developed all the time. Scientists have high hopes that people will eventually be able to use some newly developed devices and materials, such as lithium niobate and S-SEEDs (symmetric self-electro-optic effect devices), as processing elements for optical computers (see the figure).

One of the most important nonlinear effects is photorefraction. In a photorefractive substance, light intensity alters the speed at which light travels through the material. Differences in the speed at which light travels are what cause refraction. It is possible that these materials may one day be used to steer light beams or to work as optical switches (see photo 2).

Some photorefractive materials change their refractive index rapidly in response to variations in light level. Others will hold the refractive changes for some time after

If you're looking for a notebook computer that's easy to use, there are basically only two ways you can go.

The hard way.



Extra memory, $210.* *Most notebook computers in use today simply aren't fast enough to make Windows 3.1 practical. And many that are fast enough may require extra memory, which can add hundreds of dollars to their price tags.*

Clip-on trackball, $172. *If you're going to try to use Windows 3.1 on many portable computers, you may have to plug this in and clip it onto the side of your computer. (Be careful not to catch the cord in your airplane tray.)*



New programs, $506 each. *Unless you buy programs specifically designed for Windows 3.1, you'll have to use conventional character-based programs and their awkward commands.*

Added weight. *Many notebook computers may claim to weigh less than 7 pounds, but by the time you add all the components you need to make Windows 3.1 work well, you're likely to find yourself with an additional 4 or 5 pounds to lug around.*

Fax/data modem, $142. *The ability to communicate on the road is what makes a notebook PC really valuable. So you'll have to pack one of these. Once you get back to the office, be prepared to shell out another $138 to update the files on your desktop PC, and over $500 just to access network file servers and printers.*

Your time, name your price. *Fiddling around with MS-DOS or Windows 3.1 on the road can cost you plenty of time. How much is yours worth?*

Ordinary notebook, $2,497. *The typical notebook computer of today was designed to run DOS only, not Windows 3.1. It doesn't have enough memory, speed or screen brightness, and its screen isn't fast enough for high-quality graphical computing.*

Comfort *is something most notebook computer ads never talk about. Because, truth is, they're not very comfortable to use. Which may explain why they don't win awards for being well designed. (PowerBook, of course, has won more design awards than all other notebook computers combined.)*

The coach seat factor. *If you want to run Windows 3.1 on most portable computers, you'll find that you need a front-mounted keyboard and a side-mounted trackball or mouse. What you won't find is enough room on an airplane tray to hold it all.*

Instruction manual, 2 pounds. *There's nothing like forgetting a DOS command when you're 2,000 miles from home, so you may want to carry a manual with you. And since Windows 3.1 is based on DOS, you'll definitely want instructions handy.*

The Apple® Macintosh® PowerBook™ is the only personal computer to make the Products of the Year lists of *Business Week*, *Fortune*® and *InfoWorld*. And the only notebook computer to be named one of the Best Designed Products of the Year by *Time*.* Because it's the only computer designed as

The easy way.

Blistering speed. *Because Macintosh computers are optimized for graphical computing, PowerBook can significantly outperform comparably priced notebook computers running Windows.** Both the PowerBook 170 and the new PowerBook 145 deliver an impressive combination of speed and power at an affordable price.*

Consistent applications. *Every PowerBook runs thousands of Macintosh programs (including Lotus 1-2-3 and WordPerfect) that all work in the same consistent, intuitive way. You learn one, you know the basics of all of them.*

Built-in Balloon Help.™ *Point at what you want to know about, and your Macintosh will tell you what it's for. So you can leave your manual in a desk drawer at home.*

Built-in networking. *Plug your PowerBook into an AppleTalk* network, and conveniently access all network resources—printers, file servers, e-mail, even other networks from Novell, IBM and Digital.*

AppleTalk Remote Access. *This remarkable software comes with every Macintosh PowerBook. It not only allows you to access all the files on a modem-equipped Macintosh at your office or at home, it also gives you complete access to your network—printers, files, file servers, e-mail—from anywhere there's a phone.*

Built-in fax/data modem. *With this option, you can send your work directly to a fax machine or access e-mail from almost any telephone anywhere you happen to be. Just plug the phone cord into the back of the PowerBook.*

Built-in file sharing. *On most notebook computers, sharing information with a desktop computer is virtually impossible. But every PowerBook has powerful file sharing built in. So you can easily connect your PowerBook to a desktop Mac* or another PowerBook and copy files from one computer to the other.*

Built-in peripheral support. *Like every Macintosh, PowerBook lets you add up to six external hard drives, CD-ROM drives, scanners or other peripherals simply by plugging them in.*

Palm rests. *Working on the road isn't like working at your desk. So Apple designers provided a place to rest your hands, making it much easier and more comfortable to work in tight quarters—such as a middle seat on an airplane.*

Integrated trackball. *Everything about Macintosh computers is designed to make it easy for you to work. In the case of PowerBook, the pointing device is integrated into the computer. There's nothing to hook up or clip on. Open it up and you're ready to go. (It's comfortable whether you're left- or right-handed, too.)*

It's compatible. *Like every Macintosh, PowerBook is compatible with the personal computers you use at the office. It can read from and write to floppy disks from MS-DOS or OS/2 PCs, or even run DOS software using programs such as SoftPC.*

a totally integrated system. Combining hardware, software and industrial design to make working on the road as comfortable as working at your desk. It's more intelligent. It's more convenient. It's power anyone can use, anywhere you happen to be. The power to be your best.™



How to connect to a network file server.

The hard way:

1. Purchase an external network adapter.
2. Install the network adapter.
3. Connect the network cable.
4. Plug in AC power supply if needed.
5. Install network software and configure parameters.
6. Start Windows.
7. Run Windows Setup to load network software.
8. Restart.
9. Start Windows.
10. Start File Manager.
11. Select the desired file server.

The easy way:

1. Connect the network cable.
2. Open Chooser.
3. Select AppleTalk "Active" button.
4. Select desired file server.

How to retrieve a deleted file.

The hard way:

1. Purchase a utility program.
2. Install it on your computer.
3. Restart the computer.
4. Start Windows.
5. Start the utility program.
6. Start the unerase feature.
7. Find the directory where your file existed.
8. Click on that directory.
9. Select the deleted file.
10. Choose unerase command.

The easy way:

1. Double-click on the trash can.
2. Drag the deleted file out of the trash can.

How to rename a directory.

The hard way:

1. Double-click on the Main group in Program Manager.
2. Start File Manager.
3. Highlight the directory you want to rename.
4. Select "Rename" from the file menu.
5. Type in a new name for the directory (must be 8 characters or less).
6. Go to Program Manager if needed.
7. For each application in the renamed directory, select "Properties" from the file menu.
8. For each application in that directory, change the command line to reflect the new path to the application program.

The easy way:

1. Highlight the directory (folder) you want to rename.
2. Type a new name (up to 31 characters).

How to add an external hard disk drive.

The hard way:

1. Purchase a parallel-to-SCSI adapter.
2. Connect it to the parallel port.
3. Plug the drive into the adapter.
4. Insert the adapter's installation disk in drive A:.
5. Select drive A:.
6. Type "INSTALL."
7. Select appropriate options for your drive.
8. Select appropriate drive for software installation.
9. Restart.
10. Run installation test program.

The easy way:

1. Plug the drive into the SCSI port.
2. Start up the PowerBook.

How to play a sound.

The hard way:

1. Purchase a sound upgrade kit.
2. Attach sound upgrade hardware.
3. Install sound upgrade's software drivers.
4. Start the sound recorder program.
5. Select Open from the file menu.
6. Select the sound file you want to play.
7. Choose OK.
8. Click on the Play button.

The easy way:

1. Double-click on the sound's icon.

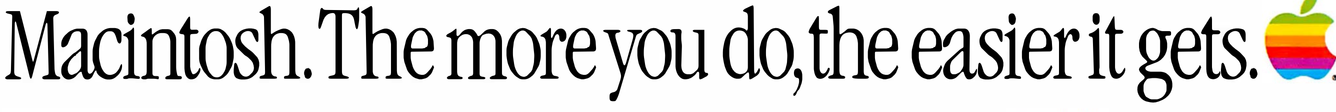
How to add a pointing device.

The hard way:

1. Purchase a pointing device (such as a mouse or trackball).
2. Open notebook's back panel.
3. Attach appropriate port adapter to pointing device (if other than 9-pin).
4. Connect pointing device to proper port.
5. Choose appropriate clamp arms.
6. Attach pointing device to clamp arms and adjust tilt angle.
7. Start the computer.
8. Install driver software.
9. Restart.

The easy way:

1. The trackball is built in.





Unbending Lightwave Terminology

diffraction The bending of light at the edge of an opaque object. Usually, diffraction is a problem because it introduces unwanted distortion, but it has useful applications—for instance, in a grating.

electro-optics Not to be confused with optoelectronics, electro-optics is a technology in which electrons are steered and focused as if they were light (e.g., in a CRT or electron microscope).

generator (or source) and detector (or receiver) There are several methods of generating and detecting optical output signals in real time and converting them to electrical signals that can be stored or otherwise manipulated. LEDs and lasers are among the devices used as generators. Photodiodes, photoconductors, and photomultipliers are some of the tools used to detect the optical output signal.

grating A pattern of microscopically fine lines that can be used to focus or redirect a beam of light. Gratings need less space than lenses and are easier to build into small photonic devices.

hologram A 3-D optical image formed by storing 3-D information about an image or a pattern of light. Where two beams of laser light cross, they produce an interference pattern of microscopic light and dark fringes. If this pattern is recorded, the result is a hologram that contains full information about the two beams that formed it.

laser A device that generates light in which all the photons are exactly in step and produce a coherent beam. Laser light has one wavelength and is more easily controlled than other kinds of light. A laser is one way to create and read holograms.

MBE (molecular-beam epitaxy) A semiconductor fabrication process used to build up devices by adding one molecular layer at a time. MBE allows different materials and types of doping to be sandwiched precisely in layers. It is an expensive and slow process, but it's essential for manufacturing various photonic devices (e.g., S-SEEDs).

nonlinear material A substance whose optical properties vary with the intensity of the light. In fact, most optical substances are very weakly nonlinear, but a lot of research has gone into finding materials with stronger nonlinearities.

OEIC (optoelectronic IC) A hybrid IC that uses both electronic and photonic technologies. One significant challenge is fabricating chips that combine silicon with optically active materials, such as GaAs (gallium arsenide).

photorefractive material A material whose refractive index (i.e., the measure of the speed of light in the material) varies with the light intensity. Photorefractive materials are widely used in photonic processing and memory.

reflection The ability of a surface to rebound light. A smooth surface (e.g., a mirror) may produce a specular reflection. A rough surface (e.g., a sheet of paper) produces a diffuse reflection.

refraction The bending of light as it passes from one medium to another. It is the phenomenon that enables a lens to focus light and that makes a stick appear to bend where it dips into water.

solitons Stable pulses that can travel indefinitely or pass through each other without losing their shape. In a soliton, the tendency for different wavelengths to travel at different speeds is canceled by the fact that different intensities also have different speeds.

S-SEED (symmetric self-electro-optic effect device) A nonlinear device consisting of hundreds of alternating GaAs and GaAlAs (gallium aluminum arsenide) layers sandwiched in a photodiode. Positive feedback in the device allows it to act as an optical switch.

waveguide A device that constrains or guides the propagation of electromagnetic waves along a path defined by the physical construction of the waveguide.

being exposed to a pattern of light, allowing the materials to operate as an optical memory (see "Parallel Optical Memories" on page 179). In fact, one of the most potent of all photonic techniques is the use of photorefractive crystals to store data as a hologram.

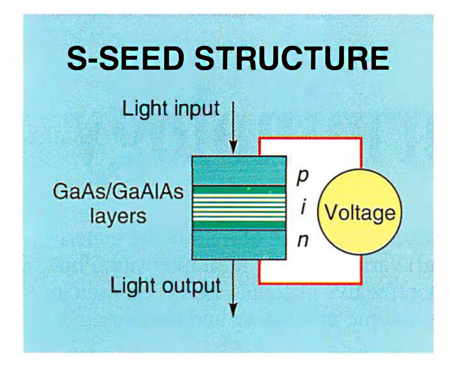
Nonlinear effects are usually not strong, but they can be amplified with a little help from the electronic world. The S-SEED links optical I/O with an electronic effect to initiate a hard nonlinearity. The S-SEED behaves as an optical transistor, performing a NOR function by allowing one light beam to switch another. S-SEEDs are difficult to make and expensive. But they provide excellent performance, with switching rates better than 1 GHz. Because they can be fabricated into arrays, S-SEEDs are also well suited to parallel processing.

Discussing his team's latest optical CPU, the O-CLIP (Optical Cellular Logic Image Processor), Desmond Smith, a professor at Heriot-Watt University (Edinburgh, U.K.), says, "Compared to electronic logic, we get gains in cycle times of a few hundred to several thousands. It's one of the best arguments that optical computers have a good future." The O-CLIP uses a 16 × 8 array of S-SEEDs, and holograms are used to configure the interconnections. Using improved lasers, Smith expects to boost performance by a factor of 1000 in the next few months.

AT&T Bell Laboratories (Holmdell, NJ) also has several photonic processors. Some centers (notably the California Institute of Technology) are making good progress with optical neural networks (see "Is What You See What You Get?" on page 189).

Fabrication Challenges

Whatever the design, fabrication is a big issue. The materials involved in developing optical techniques and components are often difficult to process, and many optoelectronic devices require time-consuming molecular beam epitaxy. The need to



An S-SEED is a p-i-n photodiode built around multiple layers of GaAs and GaAlAs (gallium aluminum arsenide). These layers act as quantum wells, trapping electrons and holes close by. The resulting energies determine the optical transmission of the device.

ensure precise alignments makes optical systems fragile and often bulky.

What the industry would like best is to manufacture photonic devices using the same fabrication techniques used to manufacture silicon electronic devices—hence the tremendous interest in electroluminescent silicon and the ability to combine GaAs with silicon on the same substrate. According to Nan Marie Jokerst, assistant professor of electrical engineering at the Georgia Institute of Technology, "The use of conventional techniques may bring to optoelectronic devices the same economy of scale that has helped lower the cost of conventional silicon circuits."

Making the Connections

One of the major obstacles to creating a working marriage between photonics and electronics is the problem of how to integrate two dissimilar technologies. If low-cost silicon-based OEICs do appear, it will be electronics, not photonics, that will benefit first. Optical interconnections will solve the connection-congestion problems in electronic computers long before optical processing becomes a commercial reality (see the text box "Interconnecting the Pieces" on page 192).

Four possible levels of optical interconnection exist inside a computer: rack-to-rack (in larger computers), optical backplanes (linking groups of circuit boards), interchip links on a single board, and intrachip connections within a single IC. Each level presents both benefits and problems, among them cost, physical size, cross talk, energy efficiency, and speed.

Choosing the most appropriate technology is a matter of trade-offs. If you want to send data from New York to London, photons are the obvious choice. If you want to send data 2 inches across a circuit board, the choice is not so clear-cut.

Electrons are less trouble because they require simpler technology. On the other hand, when space is tight, only photonics can cut through the electronic gridlock. The final decision has to be based on a balance between cost and complexity.

At present, implementing the larger-scale interconnections is easier to justify, and it's this level of implementation that has progressed the most. One of the pioneering examples of optical interconnections on the rack-to-rack scale is the 5-ESS pulse-code-modulation system developed and used by AT&T for switching long-distance and local calls. The 5-ESS contains up to 190 switching modules, each linked to central communication and administration modules by 32-Mbps optical fibers.

Honeywell (South Bloomington, MN) has demonstrated photonic backplane interconnections on the massively parallel Connection Machine produced by Thinking Machines (Cambridge, MA). Honeywell is starting to produce optical backplanes for use in conventional computer architectures (see photo 3). In a recently announced collaboration with Intel, Honeywell will develop gigabit photonic interconnections to join several Touchstone Delta supercomputer modules into a single mesh. The firm anticipates that this development will provide at least a 16-to-1 reduction in connection complexity.

The technologies now available for use in optical backplanes include free-space beams, optical fibers, and polymeric waveguides, which can be integrated into circuit boards and multichip modules (see the text box "Smart Pixels and Free-Space Interconnection" on page 174). Polymeric waveguides using channels of high-refractive-index polymer in a low-index substrate have demonstrated good performance and complex routing in conventional motherboard-daughterboard layouts.

Other researchers are investigating the practicality of different kinds of board configurations that would replace the traditional backplane. They are experimenting with optical signals that broadcast through space to several boards simultaneously. In the long run, it seems likely that board and cabinet layouts will have to adapt to photonics, just as they adapted in the evolution from vacuum tubes to transistors.

If you look at the smaller scale of intrachip links, photons begin to look less attractive than electrons. Whereas a photon's energy is independent of distance traveled, the energy required to move an electron decreases as the distances become smaller. Thus, the cost/performance ratio of electrons at the intrachip level is much better. When you get down to IC dimensions, light begins to look like a more expensive alternative.

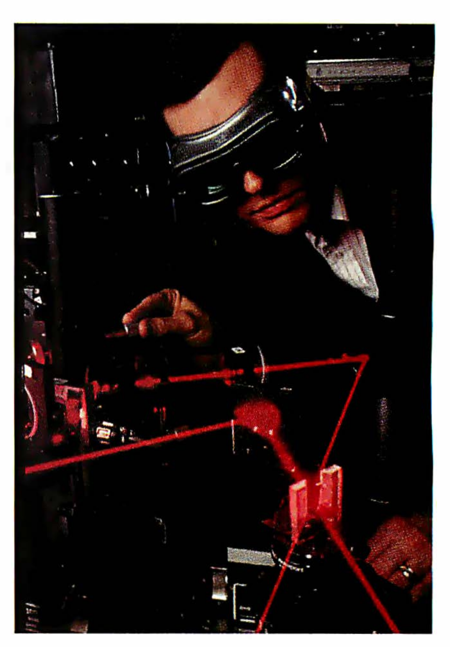


Photo 2: *Testing a new polymer that has photorefractive properties. These characteristics may lead to the development of applications such as optical memories or optical data storage many times denser than what is available today. (Photo courtesy of the IBM Research Division, Almaden Research Center, San Jose, CA)*

Will the computer industry ever implement intrachip photonics? Possibly, but not necessarily. New 3-D layered packaging technologies may use integrated optical generators and detectors to communicate between layers of the IC while retaining electronic links within each plane. Researchers at Hiroshima University in Japan have been developing one such design called the 3D-OCC (3-D optically coupled common memory). In this memory, data written electrically into any one layer propagates optically into all the others. All the layers then contain identical data, a condition that allows multiple processors to simultaneously access the same memory space for parallel computation.

Other intrachip applications may use optical waveguides fabricated in silicon to overcome cross talk or to distribute clock signals. It seems unlikely, however, that photonic transfer can ever play a large role inside 2-D devices.

Optical Transmission Developments

Outside the computer, there is no uncertainty: Communications via optical fiber is unrivaled, and new networking strategies


Hey, at least the data's safe.
Verbatim
DataLife
Verbatim® tapes, optical and floppy disks. Your best defense against data loss.

Smart Pixels and Free-Space Interconnection

H. SCOTT HINTON

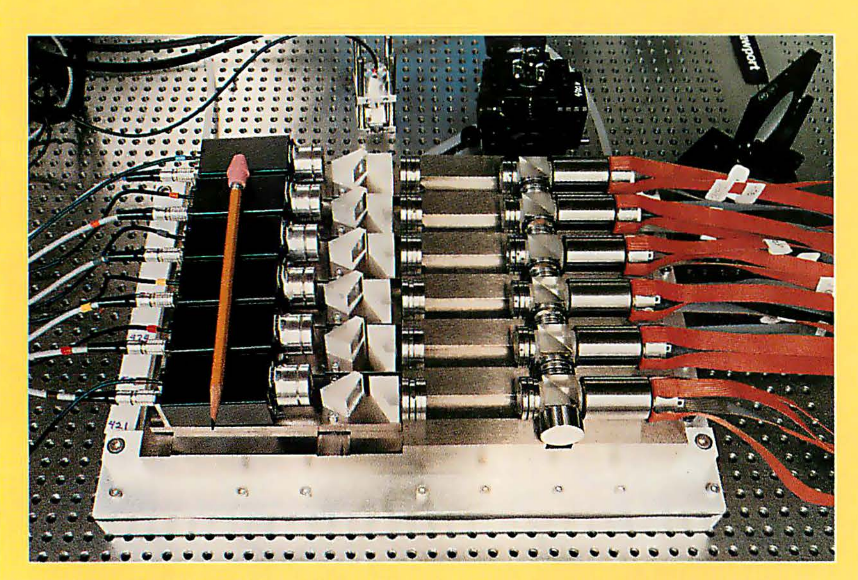


Photo A: *A 16- by 32-bit-wide multistate-interconnection-network prototype developed by AT&T Bell Laboratories (Naperville, IL). This switching fabric is based on free-space digital optical interconnections and S-SEED devices. (Photo courtesy of AT&T Bell Laboratories)*

As the performance of electronic technology continues to improve, it faces the same challenge confronted by humans: the ability to communicate effectively. The increased complexity of future processors and other ICs will require that they move more information on and off the chip. This need for increased I/O capability will lead to more pin-outs per chip. Not only will there have to be more physical channels, but the timing and synchronization of the information-bearing signals will demand tighter control.

Furthermore, as bit rates increase, so will the size and power requirements of the output drivers. These increased needs will require that more real estate per chip be devoted to I/O, a situation that in turn implies more on-chip dissipated power. Finally, as new computing architectures head away from the standard bus structures and evolve toward parallelism, they will need more highly synchronized I/O connections per chip.

Photonics to the Rescue

One potential solution to these problems is to use photonic I/O to interconnect electronic ICs. Photonic I/O offers the hope of lower communications energy per bit, which leads to less on-chip power dissipation per pin-out and less required real estate per pin-out. In addition, this will make skew rates significantly lower than with standard electrical interconnections, thus leading to improved synchronized systems.

One approach to meeting these interconnection needs is through the use of 2D-OEIC (2-D optoelectronic ICs) and free-space optical interconnections (see photo A). A 2D-OEIC is an IC that is composed of FETs (field effect transistors—standard electronic gates) with photonic I/O. The term *free space* results from the fact that the light passing from one place to another is not confined in a physical waveguide, such as a fiber.

A 2D-OEIC input is typically composed of p-i-n detectors, followed by electronic amplification. The input signals are processed electronically, with the output information transmitted to the connecting 2D-OEICs by either modulators or active sources (e.g., lasers or LEDs).

One kind of optoelectronic IC is called a *smart pixel array.* It's a special type of 2D-OEIC that consists of a 2-D array of electronic circuits with photonic I/O (i.e., smart pixels). To interconnect these smart pixels, you need a technology that can collect the spots of light (a 2-D image), leave the smart pixels, and direct the light to the appropriate input detectors of the next smart pixel.

Classical optics (e.g., lenses, beam splitters, mirrors, and holograms) is an ideal match for this interconnection need. It's one approach that can move images of light from one smart pixel array to another. A second approach is to use microlenses instead of the big and bulky classical lenses to direct the light between devices.

With the advent of frame-to-frame optical-fiber links, photonics has begun the migration into high-performance electronic systems. The next step could be shelf-to-shelf and board-to-board interconnection with both fiber and/or free-space photonic backplanes. Finally, free-space interconnection of multichip modules and 2D-OEICs could provide the connectivity necessary for future parallel systems.

H. Scott Hinton is head of the photonic switching department at AT&T Bell Laboratories. His research interests include photonic switching and optical computing systems. You can reach him on BIX c/o "editors."

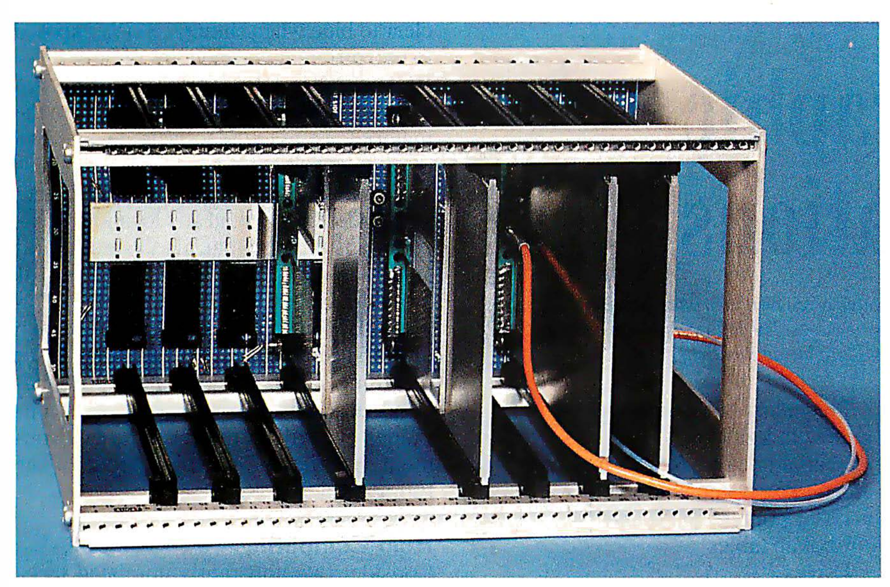


Photo 3: *Optical backplane hardware assembled in a VME card cage. Its function is to implement 32 fanouts distributed over four double-sided daughterboards inserted in the four card slots on the left side of the card cage. The prototype device was produced by Charles T. Sullivan, Bruce L. Booth, and Anis Husain. (Photo courtesy of Honeywell Systems and Research Center, Bloomington, MN)*

are proliferating—too much so, perhaps, with the winners still to be decided and compatibility keeping a low profile. The important point is that optical solutions are available for every level of networking.

One current example at the LAN scale is the FDDI (Fiber Distributed Data Interface), which provides a dual-ring topology that can reconfigure itself to survive fiber damage or faulty nodes. FDDI operates at 100 Mbps with a token-passing protocol. Some companies (e.g., 3Com of Santa Clara, CA) offer FDDI adapters as personal computer cards.

Another recent and important development is SONET (Synchronous Optical Network), a networking protocol that operates in the optoelectronic world and offers data transfer rates of up to 2.4 Gbps for metropolitan-area networks and WANs. The benefits of SONET include rapid recovery from failure and the ability to combine and separate signals at many different bit rates (see the text box "SONET: A Standard for Today" on page 186).

The first public SONET circuit was installed this year in a 5.5-mile loop around downtown Cincinnati, Ohio. Eventually, SONET may form the basis of B-ISDN (broadband ISDN) technology, which would combine voice, data, and video into one public optical network.

The thrust behind fiber research comes not from the computing environment but from the telephone world. But computer users will benefit a great deal from this work. The past year has seen significant advances in three key technologies: optical amplifiers, soliton transmission, and WDM (wavelength division multiplexing). Taken together, they could drive data transmission speeds toward the terabit range.

Optical amplifiers use erbium-doped glass and a pump laser to boost pulses as they travel through the fiber, without any need to convert and amplify them electronically. Researchers at BT Laboratories (Ipswich, U.K.) recently demonstrated an optically amplified network capable of distributing 39.8 Gbps of data simultaneously to 43.8 million terminals. And not long ago, AT&T demonstrated the use of optical-fiber amplifiers (i.e., spliced-in segments of erbium-doped optical fiber) to transmit lightwave signals error- and attenuation-free at a rate of 5 Gbps over distances of up to 5580 miles.

Solitons (i.e., pulses that maintain their shape as they travel) make optical amplifiers more efficient. They used to be a lab curiosity but are now on the verge of becoming a practical technology. Recently, AT&T Bell Laboratories' researchers have reached error-free soliton data transmission speeds of 10 Gbps over 6820 miles.

Since solitons of different wavelengths don't interact, they make possible the third emerging technology, WDM, in which separate wavelengths are used to multiplex many channels through a conventional fiber.

Without optical amplifiers, WDM would need separate boosters and lasers for each wavelength, but optical amplifiers work

Holographic Applications

Advances in holographic technology have given birth to a wide range of applications, and there are some waiting in the wings. The following is a sampling of current and near-future holographic applications.

- Computer memories
- DBMS
- Storage
- Image preprocessing and processing
- Analysis and pattern recognition
- High-resolution and 3-D displays (Toyota already has holographic heads-up displays in some of its cars.)
- Image and data encryption and compression
- Submicrometer lithography
- Computer-generated images with holographic dimensionality for application in the areas of CAD, medical imaging, and scientific visualization
- Fiber-optic wavelength division multiplexing and demultiplexing
- Precursors of systems that compute with light
- Spatial imaging (e.g., holovideo and photographic holography)
- Laser printers and scanners
- Lookup tables
- Drives
- Interferometry (e.g., nondestructive stress testing and analysis of building materials and machine parts)
- Medicine
- Infrared and x-ray imaging
- Teaching image libraries
- Optical contouring
- Optical clones of mirrors, lenses, and prisms
- Kinegrams (e.g., security images on credit cards and software)
- Packaging

over a range of wavelengths, completing the three-way synergy of erbium, solitons, and WDM.

The results of all this research are two to five years in the future, but work is well under way. Mohammed N. Islam, a research scientist at AT&T Bell Laboratories, is developing a soliton LAN that uses optical gates to read packet headers and route data without any electronic intervention (see "Light Switches" on page 183). IBM's Rainbow Project intends to use WDM to create a 1000-node optical network capable of data transfer rates of 1 Gbps per node.

Optical Storage

It's exciting to think about the coming of gigabit data channels and TFLOPS processors, but you won't get to enjoy their use without having the storage technology to match. Whether you plan to tackle the "grand challenge" problems of scientific modeling, make meaningful multimedia, or just sift through a mountain of on-line information, you'll soon need to access terabits of raw material.

For the foreseeable future, you can expect to continue with the rich mix of incompatible and semicompatible CD formats, together with WORM, magneto-optical, and phase-change drives. Static, nonrotating alternatives, such as Drexler Technology's Lasercard, are now being tested in the U.K. and the U.S. for archiving large files (e.g., medical records).

In addition, the use of short-wavelength lasers could raise storage densities by a factor of four. With this technology, you could store about 2.5 GB on a standard 4¾-inch CD, but improvements will have to be made in head design to significantly improve access times.

Optical drives and cards are not the only way to go, though. To see the essence of optical storage, you must step into the third dimension. Imagine, for example, a plastic block, the size of a sugar cube, packed solidly with a terabit of information; think of a crystal containing in its lattice the holographic image of a whole library.

Peter Rentzepis, a professor of chemistry at the University of California–Irvine, has been working on a photochromic material, spirobenzospyran, that changes from clear to blue when simultaneously exposed to two different wavelengths of laser light. By scanning the beams, Rentzepis can record bits as microscopic blue dots in the material. To read them back, he uses two ultraviolet beams. Where the beams cross at a blue dot, the dot fluoresces, allowing a photodetector to read any location. Rentzepis anticipates that his system could achieve potential read/write speeds of around 1 Gbps.

At IBM and in Japanese and German universities, other work is taking laser recording technology into the realm of individual atoms. For now, all these techniques are still in the research environment, but they give us a glimpse of the future of data storage.

Holo-Computing

Consider two apparently unrelated facts. First, the trend in all areas of high-end computing is toward greater parallelism. Second, because of its quantum nature, a photon has no path or position until it is detected. How do these facts connect? One way is in the domain of holography. Using the properties of holography and creating holograms with computers provide lots of computer-oriented applications (see the text box "Holographic Applications" at left).

In a hologram, two beams of laser light set up an interference pattern that is recorded in a photosensitive material. It's then possible to shine one beam through the hologram in such a way that it will recreate the image information and direction that was originally contained in the other beam.

Because light is a quantum phenomenon, no part of a holographic image is localized anywhere—all the parts of the hologram affect every photon in the beam. This technique is a good example of *unparalleled parallelism.*

The true beauty of holography is its versatility. Applications of the technology are many and varied. At Caltech, Demetri Psaltis has been building optical neural networks from holograms recorded in nonlinear crystals (see "Parallel Optical Memories" on page 179). At Heriot-Watt University, Desmond Smith uses holograms to direct light beams in and out of the logic arrays in his optical cellular processors. And at the Georgia Institute of Technology's Research Institute, Carl Verber, a professor of electrical engineering, is building POHMs (page-oriented holographic memories) that can store multiple patterns of data or programs and apply them in parallel to a CMOS array of processors.

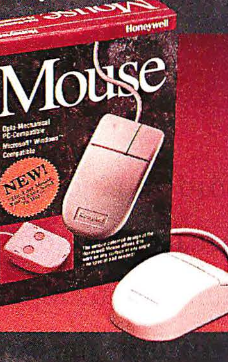
Holographic techniques will be central to photonic computing, but a great deal

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Photo 4: *Carl Verber of the Georgia Institute of Technology is building POHMs that can store multiple patterns of data or programs and apply them in parallel to a CMOS array of processors. Here you see Mark Jones, a student assistant, adjusting laser beams in a holographic switching experiment. (Photo courtesy of Georgia Institute of Technology)*

more research is required to fulfill this technology's promise. Says Verber, "The problem that's foremost in my mind is the materials problem."

In the lithium niobate crystals that Verber is using, reading the hologram erases the data. New photorefractive polymers may fix that problem, but these materials have other limitations. Scientists are confident that you will eventually be able to write and modify stable holograms as easily as any other form of memory. Then you'll see the arrival of true photonic computing (see photo 4).

Using Light

Making predictions about new technology is just asking to be proved wrong, but I can make some educated guesses about a few trends. Photonics is perhaps the only technology I know of that is capable of breaking through some of the barriers that plague electronics. In addition, this technology comes with a proven track record in the communications industry. Mohammed Islam sums it up by saying, "You're changing the application rather than the technology."

The range of possibilities that optical technologies provide is tremendous. Photonics has the power to provide us with virtual machines composed of a network of supercomputers scattered worldwide. Photonics also has the capability of squeezing an entire world of information into a handful of hologram.

There will, however, be some trade-offs. One of the many questions that will have to be faced in the future is whether software can be developed that can cope with the coming of the photonic environment. Other challenges will have to be solved, too.

Optical techniques and devices are already being integrated into our computing environment. Because of the possible commercial and technical applications they bring with them, they have the potential to greatly improve the way people process and store data. The growth of parallel and distributed computing will fuel the development of these optical technologies and be driven forward by them.

People may never compute with all-optical computers; pure optical computing may not be the way to go. Electrons offer a lot of advantages for I/O and—at least in the short term—for processing. The important need now is for the commercialization of technologies that will marry electronics and photonics so that each can fulfill its potential and allow us to use the best of both those worlds.

The photonic revolution won't be without its difficulties or its failures. In a few years' time, however, people may be wondering how they ever managed before the lights came on. ■

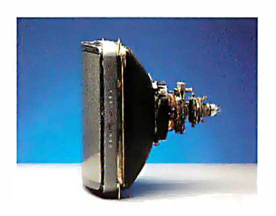
Jack Weber is a TV producer working for the BBC, making documentary films and producing the weekly prime-time science-and-technology program called Tomorrow's World. *You can contact him on BIX c/o "editors" or on the Internet at jweber @cix.compulink.co.uk.*

In The Beginning, There Was One 3.5" Drive.



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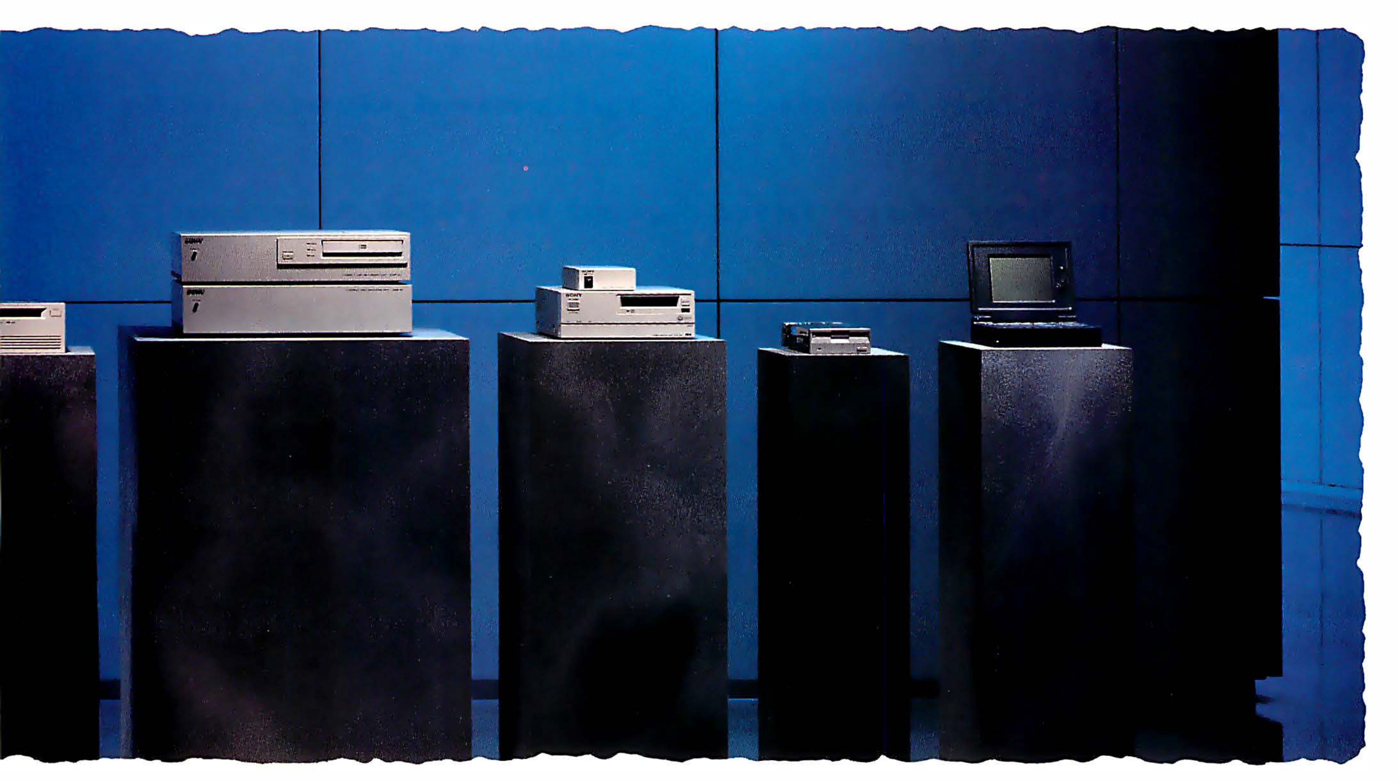


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1982: The first audio compact disc.
1983: Co-developed CD-ROM technology.
1984: The first multi-frequency monitor.
1986: The first 3Gb 12" write-once optical disk drive.
1987: The first DAT drive.
1988: The first 5.25" rewritable optical drive.
1989: The first DDS tape drive.
1990: The first writable CD.
1991: The video/computer integration protocol (VISCA™).
1991: The first 3.5" rewritable optical drive.
1992: The first portable CD-ROM XA player.



rewritable optical drive, DDS tape drive, writable CD drive, VISCA multimedia products, 3.5" rewritable optical drive, CD-ROM XA player.

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Sony product innovations spring from R&D in basic materials and new technologies. Our semiconductor research has led to new SRAM designs. Basic optical research led to the laser diodes that made CD and CD-ROM possible. And research in materials composition for magnetic and optical media led to improvements in the drives themselves.

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*1973 Emmy Award for picture quality.



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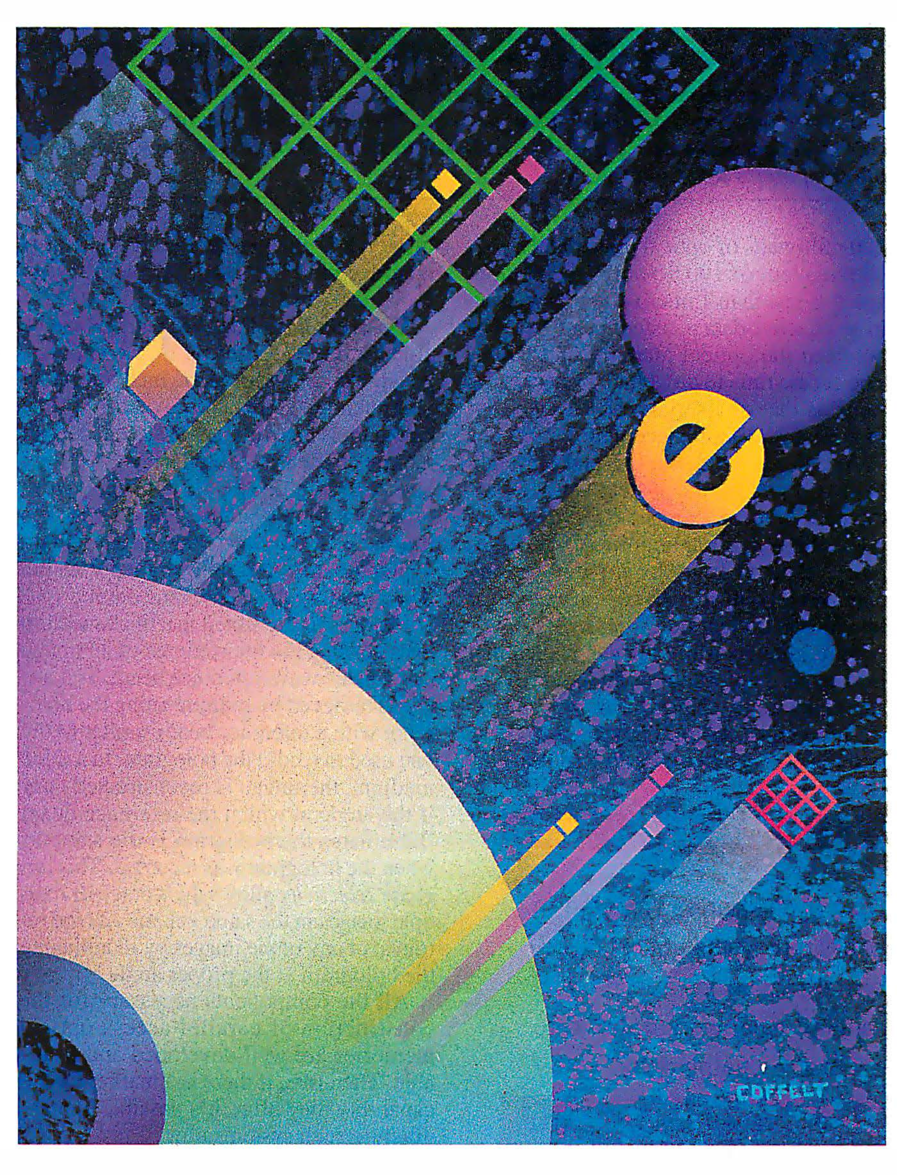
DEMETRI PSALTIS

Everyone has become familiar with optical memories and storage through their commercial applications for audio and video recordings. The same basic technology has also been applied to computer memories, with conventional systems available from many different manufacturers.

The primary advantage of optical memories is that optical disks are easily removable, which makes them attractive for applications ranging from workstations to electronic photography. In addition, it costs relatively little to produce a large number of permanent copies of an optical disk. Other properties of optical disks are roughly comparable to those of magnetic recording media.

For example, the current storage density for optical and magnetic media is approximately 1 bit per square micron. The capabilities of optical disks, however, can be dramatically augmented through parallel access. The idea is simple: The disk is illuminated with a broad optical beam instead of a tightly focused spot.

As a result, many stored bits are addressed in parallel. The bits are transferred to the computer by imaging the illuminated portion of the disk onto a 2-D detector array. The electronically detected signal can then be mapped to the RAM space of a computer through an optical RAM. Thus, it's possible to optically load information at each memory cell (see figure 1).



Doing It in Parallel

The degree of parallelism that you can achieve with this method can exceed 100,000 channels. The speed at which the data can be transferred depends on the available optical power. For example, with

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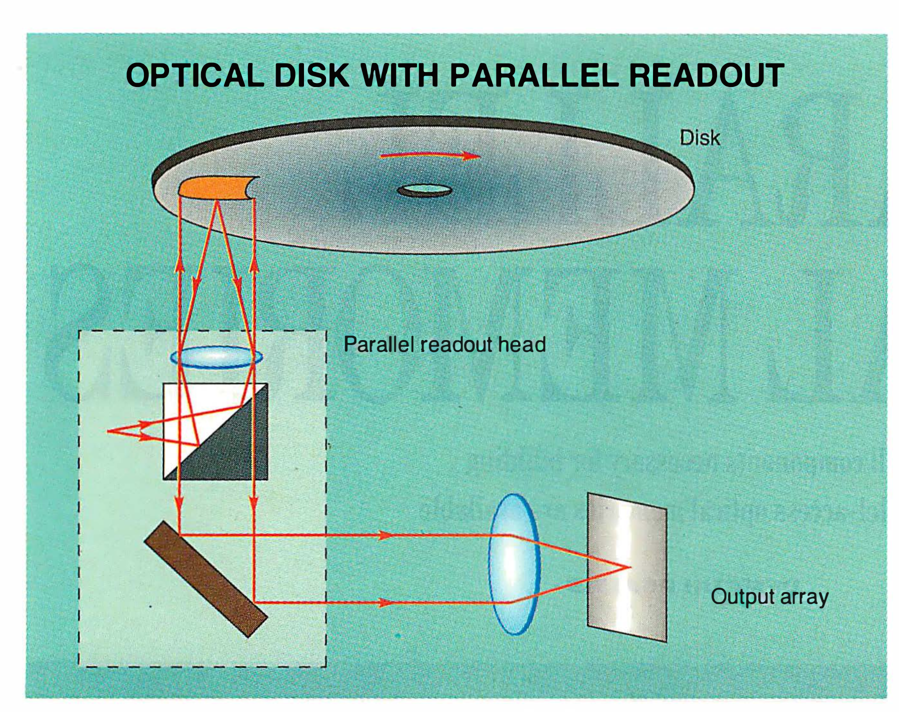


Figure 1: *A conventional optical memory disk is illuminated with an unfocused beam to address thousands of stored bits in parallel. The illuminated portion of the memory is imaged onto a detector array, and the detected signal becomes part of the computer's RAM space.*

100 milliwatts of optical power and a parallel readout of 100,000 bits, the readout speed is less than 1 microsecond, resulting in an effective data transfer rate of 10^{11} bps between the optical memory and RAM. The access time to any block of data is the same as that of a serial readout disk (approximately 50 milliseconds).

At Caltech, my colleagues and I recently demonstrated such a system using a prototype disk recorder made by Sony's Corporate Research Laboratories (Tokyo, Japan). This system is similar to any commercial optical disk system except for two important features.

First, the recording format is such that information recorded on different tracks can be spatially aligned. Second, the error-correcting coding is bypassed. These two features make it possible to draw arbitrary 2-D images on the disk. Data is recorded on the disk as 2-D blocks, with each block readout in parallel.

The recording of the 2-D patterns can be either a direct recording or a computer-generated hologram of the bit pattern that you intend to store. The advantage of the hologram is that the readout system doesn't require any lenses, simplifying the design and speeding up the access time. More important, holographic recording makes it possible to minimize the accuracy with which the disk has to be aligned with the detector array that senses the output.

Holograms are stored in a thick medium by recording the interference of an image and a plane wave reference beam. The image is retrieved by reilluminating the hologram with a reference beam similar to the one used to record the hologram. In a thick medium, the image is reconstructed only if the angle at which the reference beam illuminates the hologram is the same as when the hologram was recorded. This *angular selectivity* allows the storage of multiple images in the same volume and the retrieval of any of the images by illuminating the hologram at the proper angle.

All the components necessary for the construction of parallel-access optical memories are well developed and available. Therefore, if there is a market for the capability they offer, it's possible to manufacture such systems now.

BYTE ACTION SUMMARY

Optical memories, for use in easily removable optical disks, are attractive for applications ranging from workstations to electronic photography.

Image processing, databases, and neural networks are some of the potential applications for parallel optical memories. In such applications, you need the capability to rapidly (and sequentially) search large data sets. Using an efficient search process, it's possible to take advantage of a parallel optical memory's fast data transfer rate without its being constrained by the slow random-access time.

Associative Memories

In applications such as neural networks, it's often convenient to use an associative memory. You can use a parallel-access optical disk as an associative memory by recording a pattern that you wish to search for on an SLM (spatial light modulator). The SLM imprints the search pattern on the light beam that illuminates the disk.

The intensity of the light reflected from each location on the disk is the product of the intensity of the incident light and the disk reflectance at that point. The light that is reflected from the illuminated area is collected on a single light detector, and the detected signal is normalized to account for variations in the average intensity of different patterns. This normalized signal is at its maximum when the illuminating pattern from the SLM matches the illuminated pattern from the disk.

The system searches the associative memory by rotating the disk, sequentially illuminating different patterns on its surface and detecting the total reflected signal. With a simple maximum-detection operation, you can locate (and thus identify) the pattern that gives the best match. The output of the system is a label for the identity of this pattern.

Optical disks have advantages over magnetic storage for certain applications.

Several such systems have been demonstrated recently. In one, a handwritten-digit-recognition experiment, examples of the numbers 1 through 9 were recorded on the disk, and new patterns were classified by locating the best match between the input

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and the stored examples (up to 10,000 on one disk). Because the search completes in one disk revolution, the optical memory provides fast access to a large database.

Optical vs. Semiconductor Memories

Due to their removability and parallel access, optical disks have advantages over magnetic storage for certain applications in the near term. However, you must also consider semiconductor memories when you contemplate the long-term prospects.

Japanese manufacturers have already demonstrated experimental RAM chips that can store approximately 64 Mb, or one-tenth of the data that one disk can store. It's clear that unless the storage density of optical disks is substantially improved, semiconductor memories will become preferable except for applications where nonvolatile storage is essential. The semiconductor lasers in development with shorter (i.e., blue) wavelengths will increase storage densities, because the minimum area required for storing a pixel is equal to a wavelength squared.

3-D Optical Disks

An optical 3-D disk is similar to a conventional optical disk except that the storage medium is thick. Because of this difference, it is possible to record multiple images at each location and access any one of the images. The system mechanically rotates the disk and moves the parallel readout head so that the illuminating beam reaches the appropriate position. The system then sets the angle of illumination to select one of the images stored at that location (see figure 2).

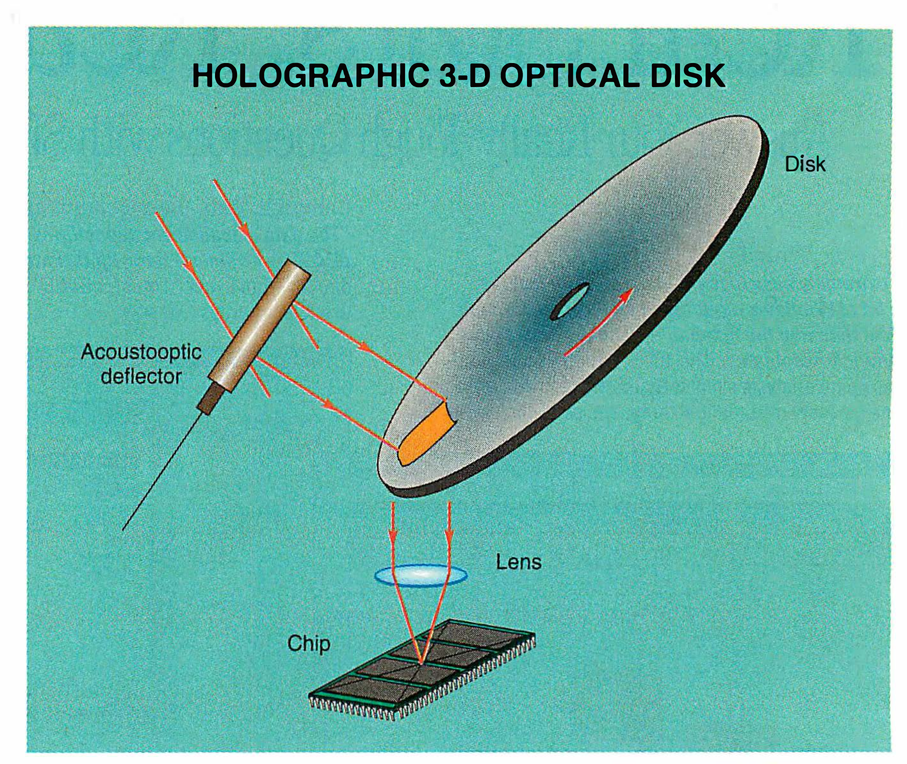


Figure 2: *In a 3-D disk, data is stored as holograms of 2-D bit patterns. Multiple holograms are stored at each location on the disk. The area of each location is approximately 10 square mm. You can retrieve each hologram by illuminating it at the appropriate angle specified by the acoustooptic deflector. Different locations on the disk are accessed by mechanically rotating the disk and translating the readout head. You can store up to 10^{12} bits on a disk 1 cm thick with a 5-cm radius.*

My colleagues and I recently stored 3 minutes of a movie on a 3-D disk using lithium niobate as the recording medium, filling only a tiny portion of the available memory space. With a 5-centimeter disk radius, each hologram occupying 10 square millimeters, and 1000 frames superimposed at each location, the storage capacity of the disk approached 10^{12} pixels—enough for more than 10 hours of video. Using such an optical 3-D disk, we could play back a 10-hour movie in approximately 10 seconds. Even though no one would want to watch movies at this speed, the capabilities of optical technology may prove critical for applications such as image recognition.

3-D Optical Memories and the Future

Two decades ago, researchers extensively explored 3-D holographic memories, but there wasn't enough progress or significant practical applications to make their development worthwhile. Now, because of advances in volume holography, there is a strong resurgence of interest in holographic 3-D memories. Contributing to this comeback are advances in optoelectronic devices, the development of new holographic recording materials, and the increased need for memories with large storage capacity.

In a recent demonstration, more than 500 images—each consisting of roughly a million pixels (10^9 bits per cubic centimeter)—were stored in a crystal with a volume less than a cubic centimeter. The large storage density, combined with the high data transfer rate and fast random access (approximately 10 µs when using an acoustooptic deflector to set the angle of the reference beam), make holographic 3-D memories exciting candidates for optical memories.

Remembering Optically

Optical memories have already proved their value in such commercial applications as audio and video recordings, but the technology's ultimate role in the computing environment has yet to be determined. Optical disks' removability offers a flexibility useful in a wide range of applications. And parallel-access optical memory's fast data transfer rates make it a potential candidate for use with image processing, neural networks, and databases. The speed and high storage density of 3-D holographic memories is a force that bears watching. In fact, there are strong indications that 3-D holographic memories could reach practical applications in three to five years.

Where research will take optical memories remains to be seen. For now, the watchword is wait and see. ■

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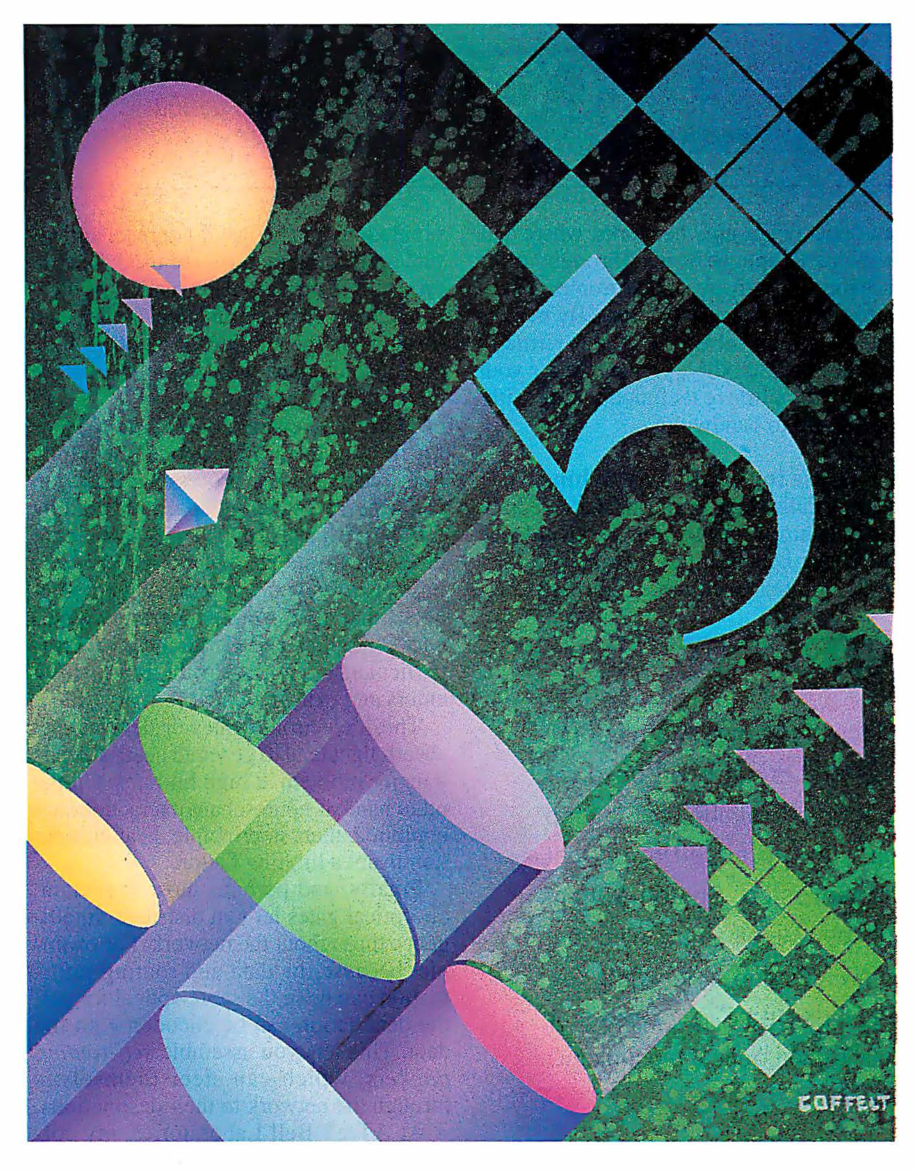
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Demetri Psaltis is a professor of electrical engineering at the California Institute of Technology. His current research is in the areas of optical information-processing systems, memories, and neural networks. You can reach him on BIX c/o "editors" or on the Internet at psaltis@caltech.edu.

LIGHT SWITCHES

Optical switches let you take full advantage of the amazing communications bandwidth provided by fiber optics

MOHAMMED N. ISLAM



Working with computer technology, you are always running into limitations that can adversely affect your applications. Not so long ago, if you didn't optimize the memory usage of your applications (even at the expense of the readability of the program code), you could easily overwhelm the capacity of your system. Now, with an abundance of memory and linear address spaces, memory requirements are less of a problem.

In communications and computer networks, however, there are still many applications that either must be optimized or can't be attempted because of bandwidth limitations. One major step toward the goal of limitless bandwidth has been the advent of optical fibers. For example, in the low-loss telecommunications wavelength range (between 1.3 and 1.6 microns) in fibers, there is approximately 40 THz of bandwidth. This bandwidth-rich environment invites innovative use of the resource. Fibers have become the transmission medium of choice for long-distance as well as short-haul telecommunications (see the text box "SONET: A Standard for Today" on page 186).

Although optical communications technology is replacing the copper wires and much of the intervening electronics in telecommunications networks, you can't get anything near 40 THz of bandwidth for your applications because electronic switches still perform the routing and logic decisions in the network. Electronic switching may be blindingly fast in human terms, but it's tortoise-like when compared to pure optical technologies.

To achieve transmission speeds approaching a terabit per second, you need

ILLUSTRATION: KEN COFFELT © 1992

all-optical *light-pipe* networks, where data remains in optical format throughout the network and converts to electronics only at the source and the destinations. By making bandwidth an inexpensive and virtually limitless commodity, you can tailor your system to optimize its functionality without regard to bandwidth.

The Case for Optical Switching

All-optical switching means that one light beam controls, or *modulates*, the passage of another light beam by interacting with it in a nonlinear medium. Light-light manipulations can be fast if nonresonant virtual optical interactions are used: The interaction is through deformation of electron clouds or wave functions rather than through the generation of electron-hole pairs, which must then recombine before the switch is reused.

There are several compelling reasons for turning toward all-optical switching for serial terabit-rate processing. First, you can achieve switching speeds exceeding 50 Gbps, which is beyond the capability of electronic systems. Second, by processing optically, you can remove the bottlenecks that arise from converting signals between optics and electronics, which is particularly important if the information enters and exits in optical format.

Third, electronic gates or devices that absorb light tend to generate heat, which is a major problem at high bit rates. On the other hand, if nonresonant interactions are exploited, then, in principle, heat dissipation is not a limiting factor.

Finally, and perhaps most important, all-optical gates let you distribute intelligence throughout the network. For example, because the data and routing information can be in the same optical format, the destination can be encoded with the data. This lets you assemble *self-routing packets*, which can steer themselves through the network to their destinations.

At AT&T Bell Laboratories, my colleagues and I have invented all-optical logic gates based on solitons that can operate at speeds of 200 Gbps. Solitons are light pulses that travel distortion-free for long distances in optical fibers. Also, we have demonstrated the components and designed the architecture for an ultrafast optical-fiber-ring LAN that is designed to have a peak data transfer rate of 100 Gbps, making it more than 1000 times faster than today's electronic systems. Although it's in the early stages of research, the optical LAN demonstrates the viability of this technology.

BYTE ACTION SUMMARY

Much of the bandwidth of optical fiber is not used because electronic switches can't keep up with the speed of optical transmission. Soliton switching lets you eliminate electronic switching in a network. You can thus create *light pipes* that fully exploit optical technology.

Solitons and Switches

Solitons are self-trapped pulses that arise from the balance between group-velocity dispersion and nonlinearity in an optical fiber. Group-velocity dispersion means that different frequencies of light travel at different speeds, and nonlinearity means that the index of refraction, or optical density, of the glass fiber changes with the intensity of light. Because of these two counteracting effects, the soliton is a stable pulse with a restoring force that makes it behave in many ways like a single particle or fundamental data unit. This is a crucial property for switching applications.

Fibers are an attractive medium in which to make all-optical gates because they have an almost instantaneous response and low-loss and excellent guiding properties—they minimize the natural property of light to diffract and lose intensity over distance. By using long lengths of relatively inexpensive fiber, you can achieve low switching energies for the logic operations.

Soliton-dragging logic gates satisfy all the requirements for devices in a digital optical processor: cascadability (i.e., the ability of one gate to drive a similar gate), fan-out, and the ability to create gates that perform the complete range of Boolean operations. They also have switching energies approaching a picojoule, which is not out of line with high-speed electronic gates. In soliton dragging, the speed, or *propagation time*, of the control pulse depends on whether it propagates alone or if it's accompanied by one or both of the signals. Physically, when the two pulses are coincident, they "chirp" each other, or change each other's center frequency, which leads to a change in velocity because of the group-velocity dispersion in the fiber.

A schematic of a NOR gate is shown in figure 1. The gate is made up of two lengths of fiber (typically the first measures about 75 meters and the second about 350 meters) coupled through a beam splitter and ending in a polarizer. The control, or power-supply pulses, propagate

along one axis, and the signal pulses are launched into the orthogonal axis.

The system assumes that you are using a clocked digital system, and the logic is based on time-shift keying (i.e., the control pulse arriving within the clock window corresponds to a Boolean one, and any other result is a Boolean zero). For example, in a typical time-shift keyed output from a soliton-dragging NOR gate, the gate is regenerative (i.e., it shows optical-level restoration); at each operation, the signal pulses are replaced by a fresh control and the signals are removed from the system by an output polarizer.

At the boundary of the all-optical system, we used another type of logic gate, a *soliton-trapping gate*, which doesn't exhibit gain or cascadability but is sensitive to the timing of the input pulses and provides an energy contrast at the output. Consequently, the trapping gates convert the time-shift-keyed signal to an amplitude-shift-keyed output, which can be detected and converted to electronic format.

Soliton-Ring Network

To explore the opportunities and challenges of using all-optical devices in system applications, my colleagues have designed the architecture for a soliton-ring network that spans several tens or hundreds of kilometers and that interconnects several hundred users. This is a self-routing packet network in which the packet size equals a typical computer word (i.e., 32 bits), so the network can be used to interconnect computers.

A simple analogy for the nodes, or information-switching points on the network, is a post office with a conveyer belt to move packages. The speed of the conveyer belt and the number of packages that are moved are limited by the speed at which a postal worker can read the addresses and sort the packages. If the worker is a speed reader, the package flow rate can be greatly enhanced. In this network design, four logic gates in the code-matching logic module are used to read the address and decide whether the packet has arrived at the proper destination. Thus, the ultrafast soliton gates serve as a speed-reading postal worker.

The design concentrates on the network access nodes, where data enters or exits the network. The code-matching logic module operates at the bit rate and uses the ultrafast logic gates to select and decode the packet address. The exchange/bypass network operates at the packet rate (i.e., 1.25 GHz) and routes incoming or new packets, and the network can be implemented using electro-optic devices. When the packet reaches its destination, it's bit-rate down-

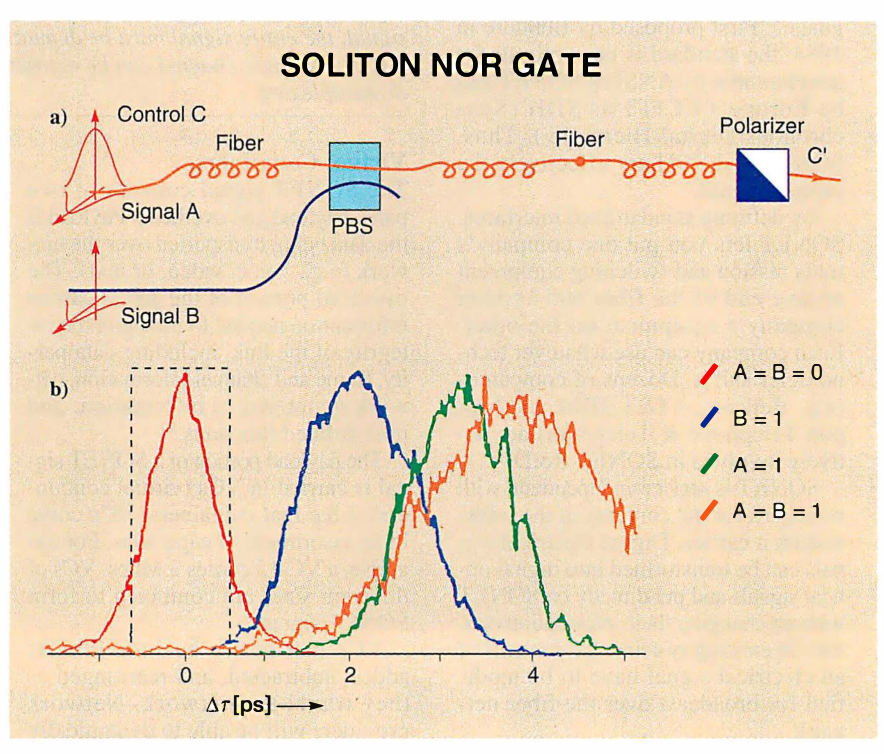


Figure 1: *Soliton-dragging NOR gates can operate at speeds of 200 Gbps, and the logical operation is based on time shifts of a control, or power supply pulse. A NOR gate consists of two fibers connected through a PBS (polarizing beam splitter) and ending in a polarizer* (**a**). *In the output of a NOR gate* (**b**), *the dotted lines correspond to the clock window, and the signal pulses drag the control out of this window in accordance with Boolean logic.*

SONET: A Standard for Today

MARK A. CLARKSON

The world is shrinking, and it's bound tighter and tighter in loops and nets of copper wire and glass fiber. Everything is connected to everything else—telephones to TR-LANs to cable TV, Tokyo to Wichita Falls.

As the information in this global network increases in volume and velocity, the links are increasingly being fashioned of optical fiber. New data services, such as broadband ISDN, require high bit rates, and optical fiber is technically superior to cable at the broadband speeds (about 150 MBps or higher).

SONET (Synchronous Optical Network) is a standard that establishes an optical communications hierarchy, ensuring that optical-fiber networks in every country "speak the same language." First proposed by Bellcore in 1984, the standard is currently under development by ANSI as SONET and by Europe's CCITT as SDH (Synchronous Digital Hierarchy). Thus, SONET and SDH are effectively the same standard.

By defining standardized interfaces, SONET lets you put one company's transmission and switching equipment on one end of the fiber and another company's equipment on the other. Each company can use whatever technologies suit it. Dozens of companies (e.g., Bellcore, AT&T, IBM, and Nippon Telephone & Telegraph) are actively involved in SONET R&D.

SONET is service-independent, with no regard for the contents of the information it carries. Digital electrical signals can be transformed into digital optical signals and put directly on SONET without changing their information content. In existing systems, the contents of an electrical signal have to be modified for broadcast over the fiber network.

SONET provides for high-capacity data links a few miles long. It carries existing services (e.g., voice, video, and ISDN) and has sufficient capacity to handle future demands.

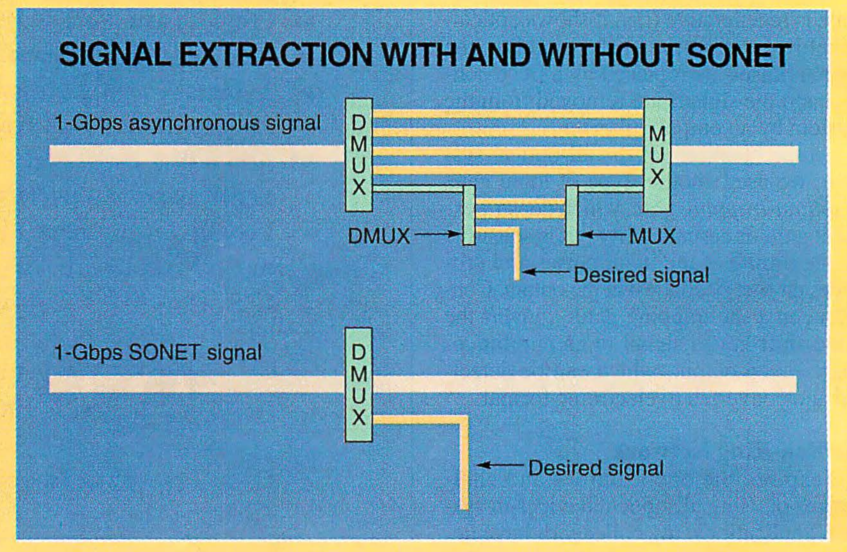


Figure A: *To extract a particular channel from an asynchronously multiplexed signal, the entire signal must be demultiplexed (DMUX) and then remultiplexed (MUX). A single channel can be extracted from a SONET signal with one demultiplexing.*

Virtual Containers

The SONET signal consists of two parts: payload and overhead. Payload is the data being transported over the network (e.g., voice, video, or text). The overhead portion of the signal carries information needed to maintain the integrity of the link, including data parity, frame and channel information, network maintenance information, and user-defined functions.

The payload portion of a SONET signal is carried in VCs (virtual containers). Like real containers, VCs come in an assortment of capacities. For example, a VC-12 carries 2 Mbps. VCs of different sizes are combined to form SONET signals.

VCs can easily be individually added, subtracted, and rearranged as they travel the network. Network providers will be able to dynamically shift bandwidth around the network, providing bandwidth on demand to end users. Also, high-bandwidth links to a customer will be easier to provide and manage.

In addition, VCs provide an advantage over asynchronously multiplexed data. Any change in the allocation of bandwidth within an asynchronously multiplexed signal requires that the entire payload be manipulated. In contrast to that, an individual channel in the form of a VC can easily be stripped from a SONET signal. The remainder of the payload passes by ignored. (See figure A.)

Such convenient signal switching also provides a basis for self-healing networks. In the event of a disruption (e.g., a cut cable or faulty equipment), traffic can quickly be rerouted over alternative links.

But is SONET fast? Its speeds range from 51.84 Mbps (one copy of the *Encyclopaedia Britannica* every 15 seconds) to 2.488 Gbps (three encyclopedias per second). The basic SONET signal is called STS-1.

STS-1 signals can be concatenated, their bytes interleaved, to create higher-speed signals. For example, three 51.84-Mbps STS-1s can be concatenated to

produce one 155.52-Mbps STS-3C. This rate is adequate to transport sophisticated services, such as broadband ISDN.

So What About FDDI?
In contrast to SONET, FDDI (Fiber Distributed Data Interface) is designed to implement LANs over relatively short pieces of fiber. FDDI has an internal clock—it can't be synchronized with the telecommunications networks. SONET could be used to connect FDDI rings, but not vice versa.

In theory, FDDI runs at 100 Mbps. In fact, however, the speed of an FDDI ring drops rapidly as terminals are added, and it's never faster than the slowest node.

Users are seeking broadband services to handle the next generation of computer applications. These applications might involve transporting huge databases around or supplying continuous streams of high-quality audio and video to the desktop.

Europe and Beyond
Optical networks are gaining ground fast in Europe, where tougher noise-emission standards make them preferable to electronic wire-based networks. As Europe's SDH evolves, SONET changes to conform with it. Both standards present a moving target to developers. Most, if not all, implementations are incomplete in one way or another. SONET and SDH have yet to be seen in their final form. Meanwhile, across the Pacific, Japan is moving, perhaps faster than anyone else, to adopt and implement SONET.

Some developers doubt that SONET, which was designed to carry gigabit signals over long distances, will be a factor in linking personal computers to each other and to their peripherals. Others aren't so sure. They think you can always use just a little more speed.

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converted, or demultiplexed, to speeds accessible by electronic shift registers. An optical feedback loop is used to synchronize the local clock to the ring data, and optical amplifiers are used to compensate for the insertion and splitter losses.

Future Applications
In general, ultrafast gates enhance the capabilities of networks whenever it is the bandwidth of the switch that limits system performance. Although the latency (i.e., delay between I/O) of the fiber gates described here is long, the devices can be used in pipelined feed-forward applications. Telecommunications applications tend to be relatively insensitive to latency, and examples of such applications that require serial terabit-rate switches include high-performance front/back ends of long-haul systems, LANs, and metropolitan-area networks.

You can also use ultrafast gates for high-speed encoding and decoding of signals to guarantee secure transmission. In addition, if the latency of all-optical gates can be reduced by using more nonlinear materials, you could find applications in distributed computing systems. Computer networks may benefit by using high-speed gates for clock synchronization and communication between memory and processors, workstations and processors, or multiple-processor machines.

All-optical devices and systems are still in the infancy of their development, and several technological areas require major breakthroughs before the field can thrive. The crucial device issue remains the lowering of the switching energy and the exploration of novel nonlinear materials to make compact devices with reduced latency and increased thermal stability. Perhaps the main missing component for all-optical systems is a compact laser source with average power approaching a watt that can act as the power supply.

Although commonly overlooked as an "engineering detail," accurate time-synchronization circuits are needed for bit periods approaching a picosecond. Finally, in a broader context, researchers and designers must craft architectures that use the switch bandwidth to enhance the capabilities of the system, enabling this ultrafast technology to make an impact. The day when network bandwidth ceases to be a limitation in your applications is in sight. ■

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THIS IS WHAT A MASSACRE LOOKS LIKE IN THE WORLD OF APPLICATION DEVELOPMENT.

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Ease of Use	9.1	8.2	8.2	7.9	7.9	7.4
Ease of Install/Upgrade	8.9	8.0	8.8	7.1	8.1	7.6
Price/Perform Return	9.1	8.3	8.5	7.5	8.1	7.1
FUNCTIONALITY						
Flexibility	9.1	8.8	8.6	9.0	8.4	8.6
Interface Capabilities	8.9	8.9	8.4	8.7	8.7	8.0
Comprehensiveness	9.1	8.8	8.8	8.3	8.7	8.7
User Friendliness	8.9	7.7	8.3	7.9	7.5	7.3
OS Compatibility	9.6	8.4	8.9	9.1	8.8	9.0
PRODUCT SUPPORT						
Documentation	9.0	8.2	8.6	5.7	6.2	7.3
Vendor Training	8.7	7.9	8.0	7.2	7.6	8.0
Problem Response Time	8.8	7.5	7.2	6.1	6.4	6.7
Quality of Vendor Support	9.0	7.8	7.5	6.4	6.9	7.0
Frequency of Releases	8.5	7.5	6.7	7.2	7.7	7.2
Response to User Request	8.8	7.5	7.8	7.0	7.0	7.3
Overall Satisfaction	9.3	8.7	8.5	8.3	8.0	7.9

Compiled from the 1991 Datapro Reports on Software/Computer System Series Software, available for each product listed (Sybase from 1992). The results are those of actual users of the products as surveyed by Datapro.

VARBUSINESS
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	PROGRESS SOFTWARE	INFORMIX	ORACLE	ASHTON-TATE	INGRES
PRODUCT FEATURES					
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Memory requirement	7.37	6.16	4.25	6.19	5.22
Ease of programming	9.03	7.09	6.06	6.20	5.90
Ability to manipulate data	9.19	7.41	7.44	6.81	5.67
Sorting capabilities	9.02	7.44	7.69	6.65	5.78
Provision for software security	8.56	6.93	7.28	5.07	5.78
Report writing capabilities	8.39	6.72	6.59	5.71	4.11
Ease of use of interface	8.51	7.05	6.15	6.10	6.10
Software integration capabilities	8.34	7.26	7.24	6.27	6.10
Ease of data retrieval	9.08	7.68	7.66	6.61	6.11
Satisfaction with product profitability	8.26	7.04	6.22	5.58	5.13
Overall quality of product	8.94	7.37	6.69	6.32	5.44
Product Features Average	8.64	7.10	6.61	6.14	5.60
SUPPORT FEATURES					
Provision for customer support	7.74	5.98	5.76	5.77	5.50
Charges for training time	6.88	4.49	4.59	5.64	4.56
Provision for technical support	7.81	5.76	5.72	5.87	5.22
Provision for marketing support	6.89	5.88	6.09	6.13	3.80
Documentation & product information	8.74	6.73	6.56	6.45	5.56
Frequency of updates & revisions	8.35	5.88	6.34	5.57	5.00
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Overall Average	8.34	6.66	6.35	6.06	5.38

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IS WHAT YOU SEE WHAT YOU GET?

Since images are optical, why not process them optically?

DAVID CASASENT

Improvements in performance and resolution have benefited traditional image-processing applications such as robotics, product inspection, reconnaissance, earth resources, and missile guidance. But despite advances in storage and processing speed, it is increasingly difficult to implement many operations in real time without a very large and expensive multiprocessor.

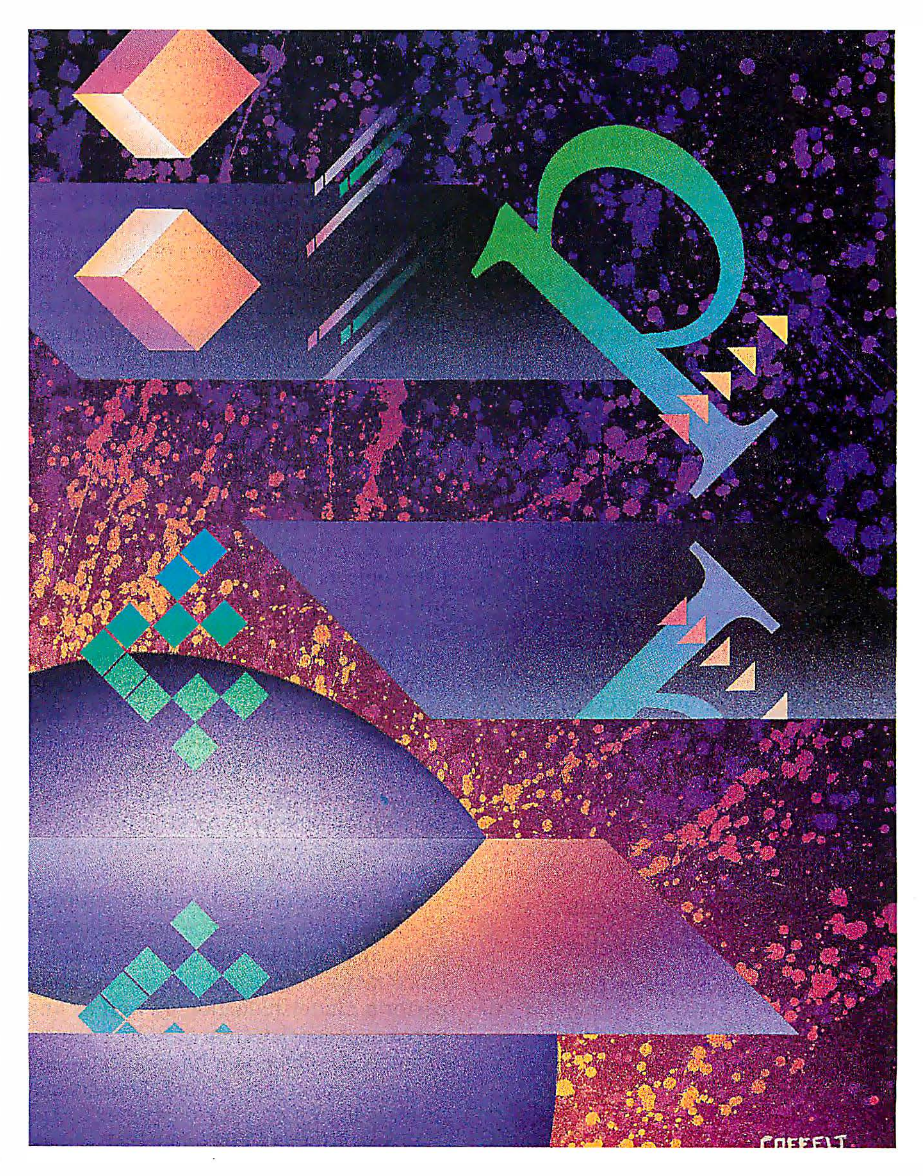
Recent optical pattern-recognition hardware and algorithm advances may offer a solution. Why not process an input optical image directly without converting it to digital data? Photons instead of electrons can perform the processing. (See the text box "Interconnecting the Pieces" on page 192.)

What Is Optical Information Processing?

Optical information processing is the use of optical hardware to process data such as images and memory contents, data between processors, and digital—as well as analog—information. Within this broad optical processing category, there are at least five separate elements: computing, interconnections, signal processing, pattern-recognition systems, and neural networks.

Optical computing refers to the use of optical-processing techniques and devices to perform logic and numeric operations to produce general-purpose optical computers or special-purpose optical coprocessors. *Optical interconnections* are unique since the paths of photons can cross without any interaction or cross talk. You will be able to optically interconnect electronic components to reduce computer clock skew, size, and volume and to improve speed, fan-out, and fan-in.

continued



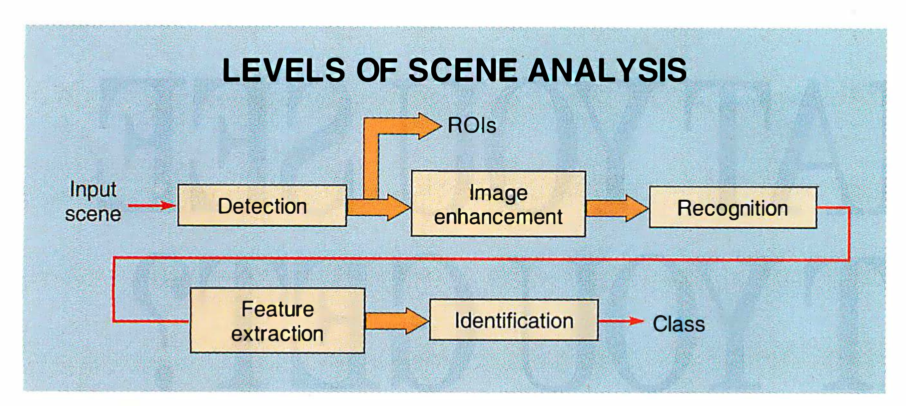


Figure 1: *The first two operations let you locate and enhance a candidate ROI (region of interest) in a scene. Then, typically, you calculate features that describe the contents of each ROI and input them to a classifier that determines the identity of the object in each ROI.*

Optical signal processors will be used for high-speed RF signal-processing functions in radar and electronic warfare. *Optical pattern-recognition systems* already perform image-processing and image-recognition functions to locate and identify objects in a scene that has clutter, multiple objects, and object distortions. This process is referred to as *scene analysis*.

For example, if you want to perform image processing for robotics or product-inspection applications, you need to locate the objects of interest in the field of view and then identify them and their orientation. This technique is called *pattern recognition*. (In product-inspection applications, the location of the object is generally known.) The operations required are feature extraction, determination as to whether or not an item (i.e., a product) is good or defective, and discovery of the nature of any defect. Finally, *optical neural networks* are coming into being for use in applications such as control, optimization, and classification.

BYTE ACTION SUMMARY

It has become more difficult to implement many operations in real time without a very large and expensive multiprocessor even though progress has been made in storage and processing speed. Advances in optical-information-processing hardware and techniques may offer solutions to this challenge.

What Do You Need?

One application for which optical processors are being used today is scene analysis. Processors for this purpose can use optical-image-processing, pattern-recognition, and neural-network techniques. If you want to combine these approaches, you can try using a hierarchical/inference approach (see figure 1), with each level of the system having a different purpose and function. A plan such as this is OK if the use of optical processing can address each level using the same multifunctional optical architecture. Figure 2 shows how an optical correlator system achieves each of the separate operations in figure 1.

The optical correlator system in figure 2 can achieve a wide variety of improved processing functions using different filters at P_2. *Correlation* is a process that locates objects *h* in a scene *f*. The operation involves placing *h* over each region of *f* and measuring the similarity of *h* and each local portion of the image. The output correlation pattern has peaks at those locations in *f* that most closely resemble *h* in a scene. Thus, you can locate multiple objects in a scene with this operation. In figure 2, the correlation is performed by multiplying the Fourier transforms of *f* and *h*, thus avoiding the need to manually move *h* over *f*.

With detection filters and structuring element filters, you can achieve all morphological or low-level computer-vision functions on a scene at P_1. These functions perform clutter reduction as well as enhancement and detection of ROIs (regions of interest). Once you have selected an ROI, you input it to P_1 and then extract features from it.

When different CGH (computer-generated-hologram) filters are placed at P_2, different features' spaces are produced at P_3. The locations and values of P_3 outputs denotes the amount of a given feature that is present. Many successful product-inspection applications use these optical feature-extractor systems.

These same features are then input to a classifier that performs the identification. (Classification is the final process that denotes the identity of each object that's in a scene—and often, too, its orientation and scale.) In this case, I'll use a neural-network classifier whose analog input neurons are these features.

These input neurons are massively interconnected to a second layer of neurons where a nonlinear weighted sum of the input neuron values is produced. Free-space optics (i.e., optical techniques using space instead of fiber as the medium) is an especially attractive way to provide the interconnection weights. (Recall that two photons can cross without any cross talk or interference; electrons and wire connections create all sorts of cross talk and interference problems.) It is also worth noting that a correlator is a most powerful shift-invariant neural network. (*Shift*, or translation, *invariance* refers to a system's ability to classify an image wherever the image appears in the visual field.) In this type of neural network, the P_2 filter is the set of weights that are simultaneously applied to all local P_1 regions (by multiplying the local P_1 neurons and summing each local product into a correlation peak output at P_3).

The advantage of neural networks over conventional classifiers is that they can simultaneously calculate multiple discriminant functions and combine them into the

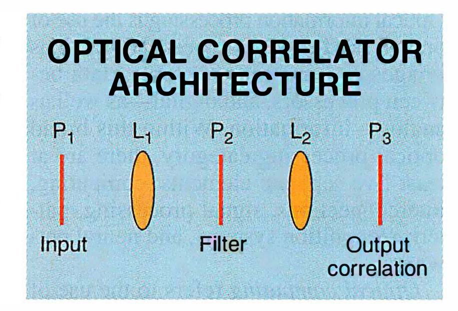


Figure 2: *You can use this optical system to compute a wide variety of features. The input image is placed at P_1, a filter is placed at P_2, and the correlation of the input and filter function appears at P_3. By using various P_2 filters, you will find that this architecture can achieve all major low-, medium-, and high-level computer-vision operations and all functions needed in figure 1.*

Interconnecting the Pieces

SING H. LEE

Optical interconnections is the term often used to describe optical communication channels linking functional units in a digital computing system. At times, it also is used to refer to the use of optics to link a number of computers for distributed processing.

Performing interconnections optically offers several important advantages over performing them electrically. Among these benefits are higher speed and larger bandwidth, freedom from electromagnetic interference or crosstalk, and less drive power when the interconnection distance is longer than the break-even line length. (*Break-even line length* refers to the interconnection distance over which a level amount of energy has to be supplied at the input to achieve interconnection.)

Other advantages of using optical interconnections include fan-out without impedance discontinuities that cause unwanted reflections, freedom from planar and quasi-planar constraints, and the ability to implement parallel pin-out. All result in higher interconnection density. For the end user, these benefits result in higher-performance computing systems that are more compact and consume less power.

The field of optical interconnections is still in its infancy, although some successful examples of optical interconnections have begun to surface. One such example is the connection of computers via optical fiber with the implementation of the FDDI (Fiber Distributed Data Interface) standard. Operating in this mode provides a tenfold improvement over Ethernet speeds.

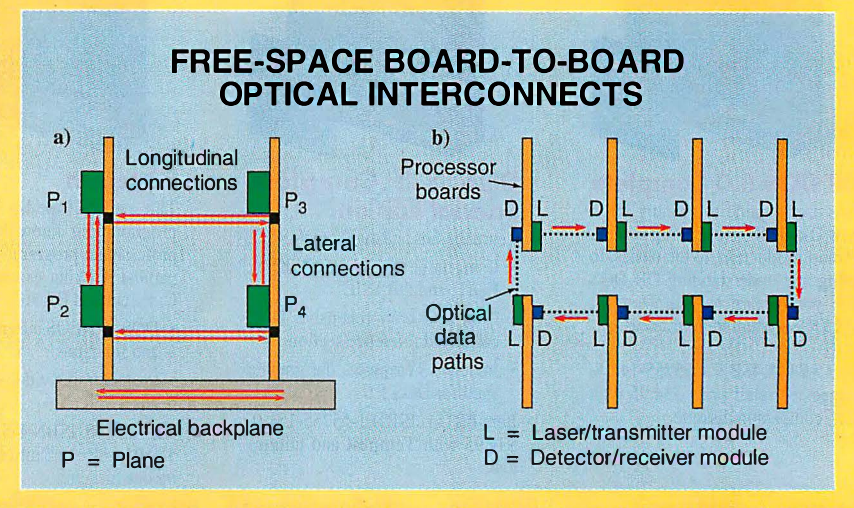


Figure A: *MIT Lincoln Laboratory research:* **(a)** *experimental module of 1-Gbps digital data links and* **(b)** *application of the high-speed data link to connect RISC-based multiprocessors on a number of boards into a ring network.*

Waveguides

Many current activities in the field are devoted to researching the applications of optical waveguides and diffractive optics. (See the glossary "Unbending Lightwave Terminology" on page 171.) These techniques solve some of the board-to-board and chip-to-chip interconnection problems encountered in high-performance computers as well as in multiprocessor parallel computing systems.

Generally, optical waveguides can provide higher interconnection densities than fibers, because fibers typically have larger dimensions—the bulk of which are associated with the cladding of fibers. Also, waveguides can be bent with smaller radii than fibers, and they can be more easily fabricated using standard microfabrication procedures. Researchers at Honeywell are working

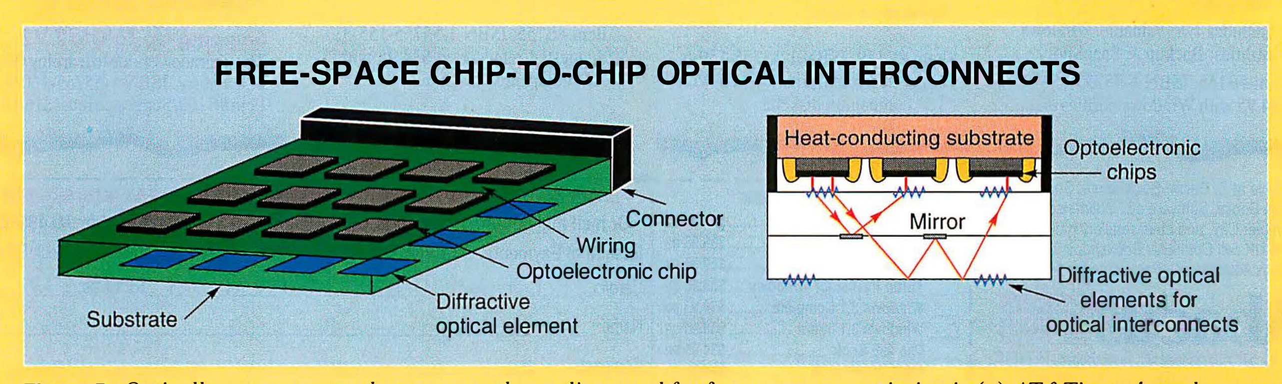


Figure B: *Optically transparent substrates are the medium used for free-space transmission in* **(a)** *AT&T's packaged module and* **(b)** *UCSD's packaged module.*

on the design of a high-density optical backplane that uses polyimide waveguides to connect many processing elements on different boards.

Researchers at the University of Arizona are working on another type of optical backplane. Polyimide waveguides are not used in this design. Instead, university scientists are employing holographic or diffractive optical elements (e.g., diffraction gratings) and the phenomenon of total internal reflection (i.e., total reflection of the optical beams between the side walls of the dielectric substrate) to guide the interconnecting beams from board to board. Since these beams are not restricted to propagating only on the surface of the substrates, it may be possible to achieve interconnection densities that are even higher than those achieved when waveguides are used.

Free-Space Techniques

Researchers at MIT's Lincoln Laboratory also are experimenting with free-space board-to-board interconnection modules (see figure A). Free-space optical interconnections allow for freedom from planar or quasi-planar constraints. (See the text box "Smart Pixels and Free-Space Interconnection" on page 174.) AT&T also is experimenting with free-space optical interconnection techniques. In much of its massively parallel optical interconnection work, scientists at AT&T are using off-the-shelf optics, custom optics, lenslet arrays, optical bistable SEED arrays, and micro-laser arrays.

Applying free-space optical interconnections to chip-to-chip interconnections offers parallel pin-outs that would lead to even higher interconnection densities and large fan-out without impedance discontinuities. This would result in improved signal-to-noise ratios. Figure B shows the approaches that AT&T and UCSD (University of California at San Diego) are trying, to replace layers of electrical interconnections by free-space optical interconnections.

One important challenge facing free-space interconnection technology is packaging. Researchers at AT&T and UCSD are working on this challenge, especially in the area of packaging electronic systems that use diffractive optical elements to perform chip-to-chip interconnections and a transparent substrate for the free-space medium.

Global Interconnection Efforts

The development of optical interconnection technology is, of course, not limited to activities in the U.S. In fact, there are very strong efforts both in Japan and in Europe. For example, optical interconnections is an important part of MITI's recently launched Real World Computing program—a 10-year program with participation from many strong industrial and academic institutions, including Fujitsu, NEC, Mitsubishi Electric, Oki Electric, Hitachi, the University of Tokyo, and the University of Osaka.

At NTT, a Cosine-2 project is devoted to building a multiprocessor system using automatically rearrangeable free-space multichannel optical switches. In Europe, the focus of the Esprit II Olive program is on optical interconnections for VLSI and electronic systems. Five industrial and five academic institutions are participating in this 60-workforce-year effort.

Because of all the concurrent activities and efforts taking place around the world aimed at developing optical interconnection technology, it isn't easy to predict how much optics future computing systems will use. However, it appears safe to say that there will be more optical devices and techniques put into computers.

Present-day computers are designed to minimize interconnections. Given a technology that could support thousands of interconnections operating at a gigabit per second each, it will be interesting to see if the architecture of future computers will remain the same or change dramatically.

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higher-order surfaces needed to discriminate many classes of objects. Optical systems are not able to easily support all the operations required in advanced neural-network learning algorithms. Thus, for learning, you use digital-hardware neural networks to calculate the required weights.

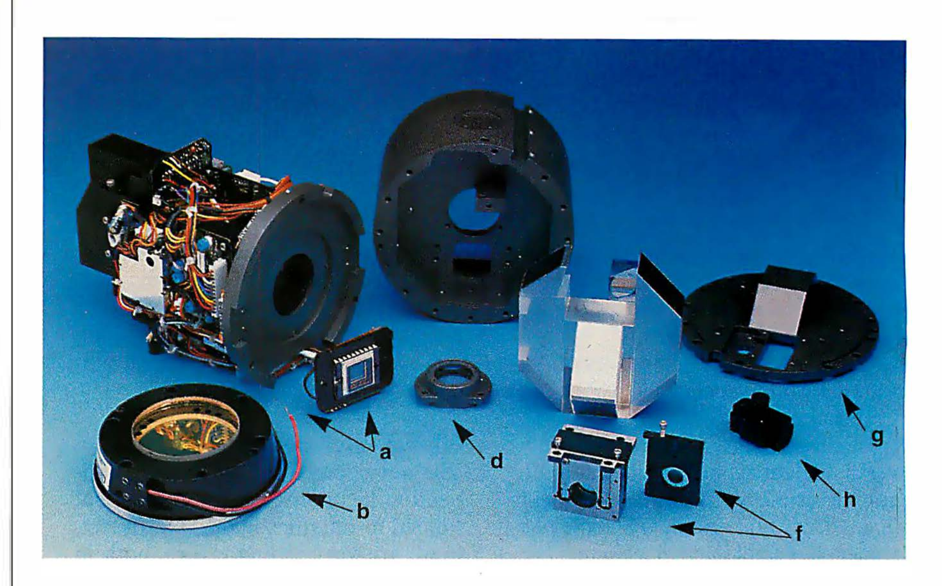
After learning has finished, you download these weights to an optical neural network. When a neural network is used as a classifier, it is a one-pass feed-forward system with no iterations, and optics provides the multiplications, additions, parallel free-space interconnections, and nonlinear functions required. Many other uses exist for neural networks (e.g., control and retinal modeling) besides their use as classifiers.

But Can I Buy It or Build It?

Perhaps five years ago, you briefly considered optical processing. You probably dismissed the idea, however, because of those huge optical benches or 2-foot-long lasers necessary to carry out the process. Also at that time, optical processors could perform only a limited number of image-processing functions. You had to use a different optical system every time you wanted to carry out another function. Besides, you couldn't go out and buy a unit or order one as a peripheral for your vision system. Well, things have changed.

Soon you will be able to more easily create your optical image-processing system.

DARPA (Defense Advanced Research Projects Agency) has now established a consortium of optoelectronic suppliers and users. Although it's not the Japanese MITI, it is bringing together sources and users. DARPA has also launched a program called TOPS (Transition of Optical Processors into Systems). TOPS's mission is to develop modular optical image- and signal-processing hardware for the major data-processing functions. With the implementation of this consortium and



The Solid Block MCSS Optical Correlator, developed by OCA Applied Optics (Garden Grove, CA), is contained inside a 4-inch-diameter cylinder. It looks at a scene through a lens with a 200mm focal length and outputs a live black-and-white video image. The components are **(a)** *the input optics and CCD (charge-coupled device) camera electronics: A 200mm lens forms a white-light input image onto the spatial-light modulator, and the camera records the correlator's output;* **(b)** *the spatial-light modulator: A liquid crystal light valve converts the input imagery's intensities into modulated polarizations that are imprinted onto the internal laser beam. These polarizations are converted back to equivalent intensities, but now they are in laser light;* **(c)** *the main housing;* **(d)** *the FT (Fourier transform) lens, which performs a 2-D FT of the input scene and images it onto the matched spatial filter;* **(e)** *the solid-block-prism assembly, which folds the correlator's optical path into a small rugged package and guarantees the optical alignment of the fold mirrors;* **(f)** *the matched spatial filter and cell, which kinematically register the photographic FT in the optical path at the FT plane: The filter diffracts all the laser energy from the object it "recognizes" into a focused spot on a CCD chip, and all other energy is scattered into a low-level background signal;* **(g)** *the rear cover; and* **(h)** *the diode laser, which is the source of coherent light for the correlator, required for FT analysis. The laser beam is confined within the correlator.*

program, soon you will be able to more easily create your own optical image-processing system.

Many recent developments in optical-processing hardware have now made it practical to build optical systems. Teledyne Brown Engineering (Huntsville, AL) has produced an optical correlator that uses modular optical elements and a solid-optics construction (i.e., no air gaps) to reduce vibration and other external effects.

Litton Data Systems (Van Nuys, CA) is currently fabricating a system called the Hockey Puck Optical Correlator. In this system (which is the size of a hockey puck), the manufacturer has mounted the optical components (all of which operate in reflection mode) around the perimeter of the device.

Through a subcontract to Optical Corp. of America (OCA) Applied Optics (Garden Grove, CA [formerly Perkin Elmer]), the Jet Propulsion Laboratory in Pasadena, California, assembled an optical correlator that is 100 millimeters in diameter and 50 mm thick (see the photo). It is to be used by MICOM (the U.S. Army Missile Command in Huntsville, Alabama). The Japanese have fabricated an optoelectronic neural-network chip, one of the first of its kind.

These are merely a few of the present optical image-processing algorithms and hardware. When the proper sequence of correlation filters is used in the hierarchical inference system of figure 1, they provide a general-purpose, programmable, optical scene-analysis processor that achieves low- to high-level computer-vision functions. ■

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Optical Product Sampler

The following companies offer products based on optical technology.

OPTICAL CORRELATORS

Litton Data Systems
8000 Woodley Ave.
Van Nuys, CA 91406
(818) 902-4000
fax: (818) 902-5052
Circle 1162 on Inquiry Card.

OCA Applied Optics
7421 Orangewood Ave.
Garden Grove, CA 92641
(714) 895-1667
fax: (714) 895-4356
Circle 1163 on Inquiry Card.

Teledyne Brown Engineering
P.O. Box 070007
Huntsville, AL 35807
(205) 726-1000
fax: (205) 726-1033
Circle 1164 on Inquiry Card.

OPTICAL MASS STORAGE

Corel Systems Corp.
1600 Carling Ave.
Ottawa, Ontario,
Canada K1Z 8R7
(613) 728-8200
fax: (613) 761-9176
Circle 1165 on Inquiry Card.

Digital Interfaces, Ltd.
13 Headlands Business Park
Salisbury Rd.
Blashford, Ringwood
Hampshire BH24 3PB
U.K.
44-425-478811
fax: 44-425-470366
Circle 1166 on Inquiry Card.

Hewlett-Packard Co.
700 71st Ave.
Greeley, CO 80634
(303) 350-4000
fax: (303) 352-3350
Circle 1167 on Inquiry Card.

Hitachi America, Ltd.
Office Automation Division
50 Prospect Ave.
Tarrytown, NY 10591
(914) 332-5800
fax: (914) 332-5834
Circle 1168 on Inquiry Card.

Introl Corp.
2817 Anthony Lane S
Minneapolis, MN 55418
(612) 788-9391
fax: (612) 788-9387
Circle 1169 on Inquiry Card.

Laser Magnetic Storage International Co.
4425 ArrowsWest Dr.
Colorado Springs, CO 80907
(719) 593-7900
fax: (719) 599-8713
Circle 1170 on Inquiry Card.

Mass Microsystems
810 West Maude Ave.
Sunnyvale, CA 94086
(408) 522-1200
fax: (408) 733-5499
Circle 1171 on Inquiry Card.

Mass Optical Storage Technologies
11205 Knott Ave.
Cypress, CA 90630
(714) 898-9400
fax: (714) 891-5126
Circle 1172 on Inquiry Card.

Micro Design International, Inc.
6985 University Blvd.
Winter Park, FL 32792
(407) 677-8333
fax: (407) 677-8365
Circle 1173 on Inquiry Card.

MicroNet Technology, Inc.
20 Mason
Irvine, CA 92718
(714) 837-6033
fax: (714) 837-1164
Circle 1174 on Inquiry Card.

Mountain Network Solutions, Inc.
240 Hacienda Dr.
Campbell, CA 95008
(408) 379-4300
fax: (408) 379-4302
Circle 1175 on Inquiry Card.

NEC Technologies, Inc.
1255 Michael Dr.
Wood Dale, IL 60191
(708) 860-7600
fax: (708) 860-9500 ext. 1126
Circle 1176 on Inquiry Card.

Online Computer Systems, Inc.
20251 Century Blvd.
Germantown, MD 20874
(301) 428-3700
fax: (301) 428-2903
Circle 1177 on Inquiry Card.

Panasonic Communications & Systems Co.
Office Automation Group
2 Panasonic Way
Secaucus, NJ 07094
(201) 348-7000
Circle 1178 on Inquiry Card.

Peripheral Land, Inc.
47421 Bayside Pkwy.
Fremont, CA 94538
(510) 657-2211
fax: (510) 683-9713
Circle 1179 on Inquiry Card.

Philips Key Modules
2001 Gateway Place, Suite 650W
San Jose, CA 95110
(408) 453-7373
fax: (408) 453-6444
Circle 1180 on Inquiry Card.

Pinnacle Micro
19 Technology Dr.
Irvine, CA 92718
(714) 727-3300
fax: (714) 727-1913
Circle 1181 on Inquiry Card.

Plasmon Data Systems
1654 Centre Point Dr.
Milpitas, CA 95035
(408) 956-9400
fax: (408) 956-9444
Circle 1182 on Inquiry Card.

Procom Technology, Inc.
2181 Dupont Dr.
Irvine, CA 92715
(714) 852-1000
fax: (714) 852-1221
Circle 1183 on Inquiry Card.

Ricoh Corp.
5 Dedrick Place
West Caldwell, NJ 07006
(201) 882-2000
fax: (201) 882-5840
Circle 1184 on Inquiry Card.

Sony Corp. of America
1 Sony Dr.
Park Ridge, NJ 07656
(201) 930-1000
Circle 1185 on Inquiry Card.

Storage Dimensions, Inc.
1656 McCarthy Blvd.
Milpitas, CA 95035
(408) 954-0710
fax: (408) 944-1200
Circle 1186 on Inquiry Card.

Tecmar, Inc.
6225 Cochran Rd.
Solon, OH 44139
(216) 349-0600
fax: (216) 349-0851
Circle 1187 on Inquiry Card.

Ten X Technology, Inc.
4807 Spicewood Springs Rd.
Building 3, Suite 3200
Austin, TX 78759
(512) 346-8360
fax: (512) 346-9580
Circle 1188 on Inquiry Card.

Toshiba America Information Systems, Inc.
9740 Irvine Blvd.
Irvine, CA 92718
(714) 583-3000
fax: (714) 583-3499
Circle 1189 on Inquiry Card.

MEMORY CARDS

Drexler Technology Corp.
2557 Charleston Rd.
Mountain View, CA 94043
(415) 969-7277
fax: (415) 969-6121
Circle 1190 on Inquiry Card.

HOLOGRAPHIC PROCESSORS AND SYSTEMS

Advanced Digital Holographics & Holographic Dimensions
16115 Southwest 117th Ave.,
Unit 21A
Miami, FL 33177
(305) 255-4247
fax: (305) 255-0339
Circle 1191 on Inquiry Card.

Advanced Holographics
10440 Ontiveros Place, Unit 1
Sante Fe Springs, CA 90670
(310) 941-2067
fax: (310) 946-5743
Circle 1192 on Inquiry Card.

American Bank Note Holographics
4 Westchester Plaza
Elmsford, NY 10523
(914) 592-8860
fax: (914) 592-3348
Circle 1193 on Inquiry Card.

The Lasersmith
1000 West Monroe St.
Chicago, IL 60607
(312) 733-5462
fax: (312) 733-5926
Circle 1194 on Inquiry Card.

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■ 4– Architectural Record ■ 7– A/C Flyer, Aviation Week & Space Technology, AW & ST China Quarterly, AW & ST USSR, Business & Commercial Aviation, World Aviation Directory and Buyer's Guide ■ 20– Business Week, Business Week China, Business Week Hungary, Business Week International, Business Week USSR ■ 28– Chemical Engineering ■ 32C– BYTE, Data Communications, Data Communications International, LAN Times, UnixWorld ■ 39–Electrical World ■ 41– ENR, Construction News Publishing Network (11 magazines, 4 newspapers) ■ 46– Global Finance ■ H6– The Physician & Sportsmedicine, Postgraduate Medicine ■ 114– Modern Plastics, Modern Plastics International ■ 117– Power, Power International



PROFILES IN DOCUMENT MANAGING



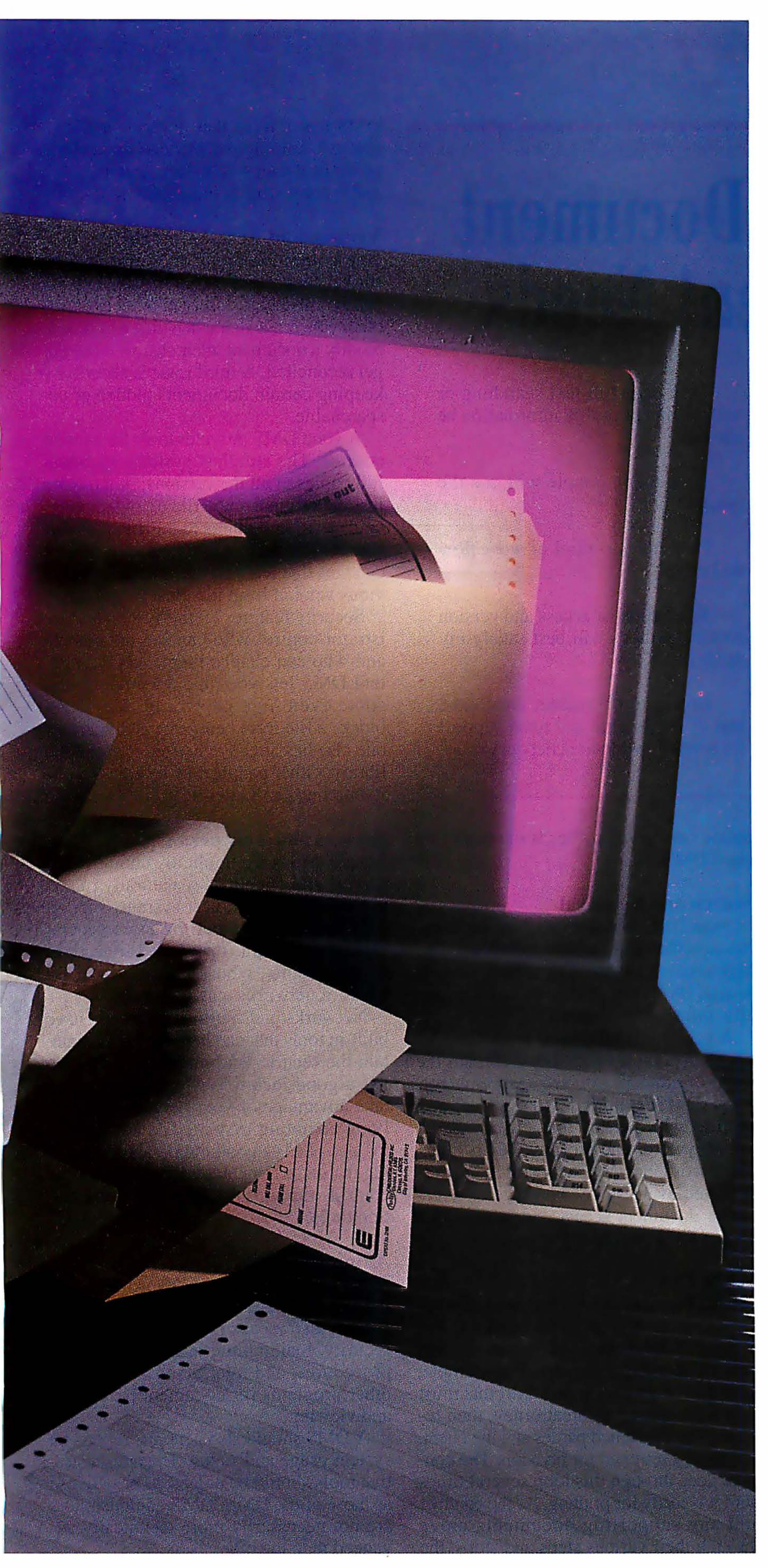
Businesses generate billions of pages and terabytes of data a year; a good DMS can help you keep track of all that information

RAYMOND GA CÔTÉ AND BEN SMITH

Every day, businesses spend countless hours generating and filing forms, reports, contracts, letters, records, marketing material, and engineering diagrams. They also spend hours looking for those documents—or looking not just for one but for a number of related documents. Finding everything in the corporate filing cabinet that has to do with Subject A is not easy with traditional paper-based filing methods, even in the best libraries.

One approach to organizing tons of text is with so-called text management programs (see "Searching for Common Threads," June BYTE). These programs are good at indexing documents and then searching them for specific words or phrases. But DMSes (document management systems) go far beyond that. They file everything—text and images coming straight from a computer or scanned in from paper—in an electronic library, storing it all in a form that can be quickly searched for, retrieved, shared by hundreds of people, and kept in a tiny space. Most DMSes also provide a means for passing documents around, either across a network or from fax to fax. Although they will not reduce the amount of information pouring into your office, DMSes, such as the ones we review here, can help you get a handle on the problem.

In broad terms, DMS products fall into two categories: those designed primarily to handle text (i.e., feeding it into an indexed archive) and those designed primarily to handle images (i.e., turning a page of print into a digital picture and then storing it in an indexed archive); some programs can handle both text and images. For this review, we chose products representative of each approach. SoftSolutions for DOS and PC DOCS (Document Organization & Control System) are indexing and retrieval engines extended with functions to manage the gathering, tracking, storing, and searching of documents. Imara and Keyfile are image-based systems. They handle documents that come in from a scanner or fax, store them as pictures, and provide the means for sharing the library of imaged documents. (See the table



BYTE ACTION SUMMARY

■ **WHAT DOCUMENT MANAGEMENT SYSTEMS DO**
They let you store, search, and manipulate documents electronically to maintain a library of text and images in a compact space.

■ **LIKES**
The ability to conduct fast searches through volumes of data and quickly retrieve documents; reduction in paper clutter.

■ **DISLIKES**
Initial installation and learning curve can be daunting.

■ **RECOMMENDATIONS**
Keyfile 1.0a is a good image management system with an excellent iconic interface. PC DOCS 4.1 doesn't have the extensive search capabilities that SoftSolutions for DOS 3.0 has, but it's still a good, easy-to-use desktop system for managing megabytes of text documents.

for summary information about the four DMSes profiled in this review.) While there are many other DMSes on the market offering a wide range of capabilities (see the text box "Tools for Lassoing the Paper Cyclone" on page 206), the four products we reviewed represent accessible, PC-based systems that won't tax your bank account.The elements of document management are the following:

- document content profiling
- indexed search and retrieval
- document work flow
- access and version control
- administration
- LAN/WAN (wide-area network) support

We examined these main areas as we evaluated the products. They are the basic aspects to consider when you're looking to buy a DMS. Setup and operation are also important. If a DMS isn't easy to learn and use, it will seem more like a hindrance than a helpful tool. Performance is also important, but it will depend greatly on how many documents you have, what type of documents they are, what sort of network you're running on, what your server is, what sort of load it endures, and so on. (See the text box "Evaluating Document Management Needs" on page 200 for more on this subject.)

In our tests, the different systems all

Evaluating Document Management Needs

Document management systems are necessarily complex, but they should be simple to use and manage. To evaluate what you need in the way of document management (or to determine if you even need it), ask yourself the following questions:

√ How many different document formats do I need to manage?

√ How many documents of each format do I anticipate?

√ What are the storage requirements for each format?

√ Do I need full-text searching or will document profile information be enough?

√ How many people will use the system?

√ How much control of work flow do I need?

√ What kinds of access and version control methods will best satisfy my needs?

√ Do I expect to manage distributed sets of documents and need support for a WAN (wide-area network)?

turned up documents quickly, but a more rigorous test for a DMS is an enterprise that handles thousands of pages a day, with dozens of people tapping into the network to hunt for and retrieve documents. In the following sections, we'll discuss the main areas you should investigate when evaluating a DMS.

Profiles

A profile is the information that describes a document. It includes the type of document (e.g., a WordPerfect file, a scanned image in TIFF, a Lotus .WK1 file, and so on) that was entered into the system, who created it and where, where it is stored in the DMS, and other bits and pieces. The profile screen is often the point of entry for using the system.

The work of profiling documents can be time-consuming if done by hand, and the process should be automated as much as possible. A good document management environment will already have information about who created what document, when, and with what application. Some DMSes gather this information by monitoring the system and capturing a document as soon as you store it. (For example, when a PC DOCS user finishes writing a document and closes the file, the DMS automatically grabs the text and adds it to the document library.) The ability to define your own profiles is the mark of a good DMS.

Search and Retrieval

In most DMS installations, finding documents is the most important function. The objective is to locate a specific document as quickly as possible with as little specific information as possible.

A good retrieval system produces a hit list of documents found that contain the word or concept you are searching for. Some DMSes index just keywords and profiles, which means that you can search only keywords and profiles. Others index every word in every document in the system. Retrieval also involves logging a record of document access and launching a viewer for a particular file type.

Work Flow

A real DMS can process documents, shepherding them through stages of editing and review. Different kinds of documents may have to take different paths. For example, a contract may start with a draft that must first be approved by an attorney, then reviewed by concerned parties and the client, and finally returned for revision. The contract goes through this loop several times until it is ready for printing. As the contract and any supporting documents move through their various steps and stops, the DMS has to track their location and contents. A complete DMS can associate a predefined path with a document and track and control what is happening to it.

Version and Access Control

One common danger in working with shared documents is that an early version can be mistaken as the most recent. Another concern is that when different people modify a document, their changes may not get reconciled. A third issue is security—keeping certain documents hidden or unsearchable.

A good DMS provides tools for version control. The simplest systems maintain full copies of all the versions; others keep just the original and a file of any changes made to it; and others maintain a copy of the most recent version and a list of changes that lets you reconstruct any previous version from the most recent one.

Security features let the system administrator control who can see documents and who can change them. Any competent DMS lets you hide documents, and some even hide keywords. The DMS blocks a file from being changed if someone else has already checked it out of the library. Other people may be able to view it, but they can't alter it.

Servers and Networks

Since DMSes are implicitly composed of servers and clients, they naturally run on networks. The simplest systems support only one network, but the more general DMSes can handle distributed collections of documents, where several different kinds of networks may be involved.

Networks and multiuser systems have built-in tools that can help the DMS maintain the security and integrity of data, so it's a good idea to buy a DMS that can take advantage of your network's underlying operating system. The administrator also needs a good interface for accessing the underlying network resources and controls through the DMS's administration tools.

Administration

DMS administration involves more than installing the software and backing up the files. It also means managing access and security, maintaining indexes, enforcing procedures, and interfacing the DMS to other programs for document processing and viewing.

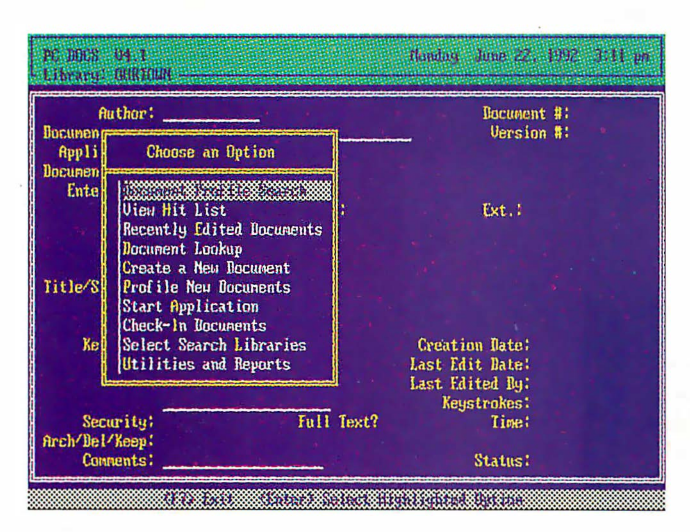
A DMS should also generate reports on system usage and status. The administrative tools should be at least as easy to use as those of the DMS; DMS administrators are not necessarily more technically advanced than the other users.

continued

PROFILE OF FOUR DOCUMENT MANAGERS

PC DOCS and SoftSolutions are aimed primarily at managing text files. Keyfile and Imara are primarily for handling documents as images.

	PC DOCS 4.1	SoftSolutions for DOS 3.0	Imara 2.1	Keyfile 1.0a
Price	$295 per workstation	$495 per server, $295 per workstation	$2995 per two users (includes server software)	$995; LAN: Windows, $1995 for 5 users; OS/2, $4995, unlimited users
Platform	DOS	DOS, Windows, Unix	OS/2, Windows	OS/2, Windows
Key features	Document control, full-text searching, version tracking, activity log, NetWare integration, WordPerfect interface, WAN support	Document control, full-text searching, SpeedSearch, activity log, mass importing of documents, version tracking, WAN support	Converts documents to images, E-mail, fax in/out, OCR option, query by form or keyword, iconic interface	Handles images and text, work flow, fax in/out, files-and-folders metaphor, iconic interface



Screen 1: *PC DOCS presents a menu-driven interface. From this point, you can access the program's main functions, such as searching profiles, making new documents, and searching for documents.*

PC DOCS 4.1

PC DOCS is a text-oriented client-/server-based DMS that has DOS clients and a NetWare/Btrieve server. Like SoftSolutions for DOS, it uses character-based menus and forms for document management operations. The program is tightly coupled with NetWare (using Btrieve as its database manager) and WordPerfect, intercepting WordPerfect keystrokes and letting you invoke PC DOCS from within the word processor.

Menus seldom exceed nine items. They can, however, extend three or four levels deep. From PC DOCS's main menu (see screen 1), you can search document profiles, view hit lists, see recently edited documents, look up documents, create new documents, profile new documents, start applications, check in documents, select search libraries, and run utilities as well as reports.

The default operation is a profile search. It is through the profile-search form that you can access the full-text search. The search functions let you create combined profile and full-text searches. Boolean operations are not limited to the full-text search but can be applied in any of the profile fields as well.

With the Search Libraries function, you can look in more than one collection of documents. You can even have the separate libraries on separate servers, as well as under separate directories.

PC DOCS returns from a search with a *hit list*—the list of documents that match the criteria you have specified. As you scroll through the hit list, the top half of your screen pages through a brief summary of the profile of the document associated with the current hit-list item. Retrieving a document means that you are using an external application for viewing or modifying it.

PC DOCS's built-in file viewer is geared to looking at WordPerfect documents, but it can also handle many other word processing files. Looking at documents in the file viewer, however, requires that you select a document from the list and then return to the viewer. This seriously slows down the process of visually selecting documents from the hit list.

Depending on how the administrator sets things up, PC DOCS will let you look at an image file either by launching the application used to generate the image or by using a third-party package to view it. In the case of an image file that contains prose—a Harvard Graphics presentation, for example—you can have PC DOCS add the text to the index.

With PC DOCS, you can interface to just about any DOS application. PC DOCS merely launches the application with the parameters that the supervisor has specified in the application installation and maintenance table.

PC DOCS relies heavily on NetWare and its Btrieve engine for maintaining security, but it also goes further and provides profile-level security and hidden profiles. This DMS controls which users and groups can launch which application programs.

The program's version-control system lets you retrieve any version of a document. You can also start a branch version from any version. For example, if your most recent version is 4, you can still retrieve version 3 and use it to create new versions: 3a, 3b, and so on. This sort of version control is especially useful when you're working with legal documents, where there may be different versions for different jurisdictions.

PC DOCS also lets you check a document out of the system. This essentially locks the document so that no one else can revise it until you return it.

For a DMS, PC DOCS's resource requirements are modest. To run PC DOCS, you need a server running NetWare 286 version 2.15 or 2.2 or NetWare 386 version 3.11. You also need about 1.5 MB of

"*The importance of the program cannot be overlooked... it so fundamentally alters the mechanics of mathematics.*"
New York Times

"*Mathematica is a startlingly good tool.*"
Nature

"*Mathematica has the potential to change the world of science at least as much as word processing has changed the world of writing.*"
InfoWorld

Mathematica®

A System for Doing Mathematics by Computer

Function: Numerical, symbolic, graphical computation, interactive programming. Integrated technical computing environment.

Numerical Computation: Arbitrary-precision arithmetic, complex numbers, special functions (hypergeometric, elliptic, etc.), combinatorial and integer functions. Matrix operations, root finding, function fitting, Fourier transforms, numerical integration, numerical solution of differential equations, function minimization, linear programming.

```
In[1]:=
 3^70
Out[1]=
 2503155504993241601315571986085849
In[2]:=
 Hypergeometric2F1[7,5,4.1,3-I]
Out[2]=
 -0.00403761 - 0.00295663 I
```

Numerical Computation

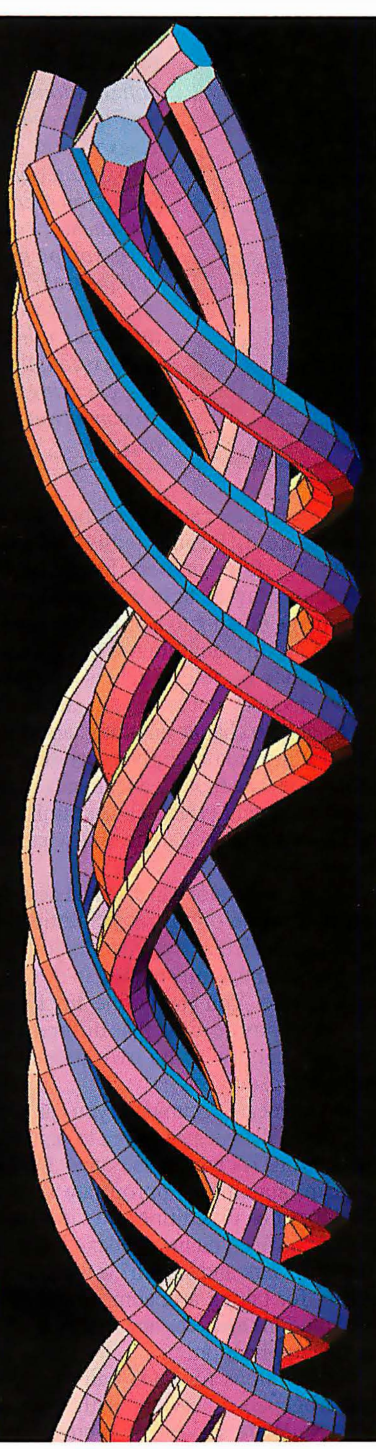
Symbolic Computation: Equation solving, symbolic integration, differentiation, power series, limits. Algebraic operations, polynomial expansion, factorization, simplification. Operations on matrices, tensors, lists, strings.

Graphics and Sound: 2D, 3D plots of functions, data, geometrical objects. Contour, density plots. 3D rendering with intersecting surfaces, lighting models, symbolic descriptions. Combining and labeling graphics. Color PostScript output, publication quality graphics, animation (most versions). Sampled sound generation from functions and lists.

```
In[1]:=
 Integrate[x/(a + Exp[x]), x]
Out[1]=
  2              E^x
 x      x Log[1 + ---]
                   a
 --- - --------------- -
 2a          a
                       E^x
          PolyLog[2, -(---)]
                        a
          ------------------
                  a
```

Symbolic Computation

Programming: High-level, interactive, symbolic system. Full procedural language, functional programming constructs. General transformation rule paradigm based on pattern matching.



Graphics and Visualization

External Interface: Input from external files, programs. Expressions, strings, words, records, numbers (in *Mathematica* or Fortran format), with arbitrary word and record delimiters. Output in TeX, C, Fortran, PostScript. System functions, file manipulation. External function calls, general interprocess communication, and data exchange via *MathLink*™.

Notebook Front End (Macintosh, NeXT, Microsoft Windows): Based on word processor analogy. Notebook interactive documents mixing text, graphics, animations, *Mathematica* input, output. On NeXT and Macintosh, front ends can be used with kernels on other computers, and support sound.

Documentation: *Mathematica: A System for Doing Mathematics by Computer*, Second Edition, by Stephen Wolfram (Addison-Wesley, 1991) available at bookstores. Additional documentation supplied with specific versions. *The Mathematica Journal* published quarterly by Miller Freeman. Many other *Mathematica* books also now available.

Versions Available: Macintosh • MS-DOS • Microsoft Windows • CONVEX • DG AViiON • Digital Equipment Corporation VAX/VMS, RISC ULTRIX • HP 9000 • HP Apollo • IBM RISC Systems/6000 • MIPS • NeXT • Silicon Graphics • Sony • Sun-3 and SPARCstations • Educational, volume, reseller, and other discounts available • Now shipping Version 2.

```
log[1] = 0
log[E] = 1
log[x_ y_] := log[x] + log[y]
log[x_^n_] := n log[x]
log'[x_] := 1/x      (* derivative *)
log/: InverseFunction[log] = exp
log/:
Series[log[x_], {x_, 1, n_}] :=
  Sum[-(-1)^k (x-1)^k/k, {k,1,n}] +
                 O[x,1]^(n+1)
```

High-Level Programming

Implementation: 843 pre-defined *Mathematica* functions (kernel C source 330,000 lines).

Typical Applications: Research, engineering, education, mathematical modeling, publication graphics, data analysis, visualization, systems analysis, algorithm development.

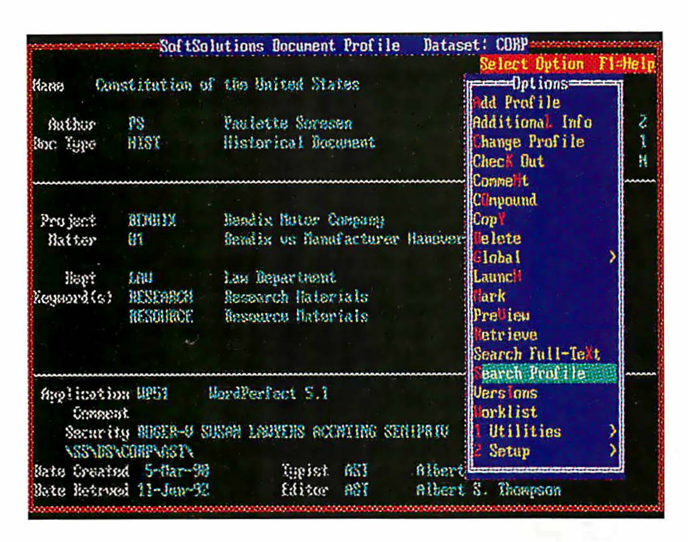
Awards: *MacWelt*, 1991 • *Macworld*, 1990-91 • *Discover*, 1990 • *BYTE*, 1989 • *MacUser*, 1989 • *Business Week*, 1988 • *InfoWorld*, 1988

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For Macintosh information circle 187, for IBM/Compatible information circle 188, for UNIX information circle 189 on Inquiry Card.

storage space per 1000 documents and 1 MB of RAM for each 100 MB of server disk space. For a workstation, you must have at least a 286 with 640 KB of memory, plus 1 MB of extended or expanded memory; you'd most likely want a 386 with 2 MB of memory and a hard drive.

PC DOCS doesn't pretend to be a feature-rich DMS along the lines of those designed for mainframes or big Unix systems (e.g., BRS Software Products' BRS/Search). It is not intended for operations where there needs to be sophisticated control of work flow. Rather, it succeeds admirably as an easy-to-use desktop DMS that lets you index, store, and search reams of documents. It relies on NetWare and plugs into WordPerfect, so if you are already using those two products, PC DOCS will be a natural fit. What it does, it does well and in a predictable way.



Screen 2: *A SoftSolutions profile screen gives you the who, what, and where for every document. From here, you pick options such as searching text, launching other applications, and checking documents in and out.*

SoftSolutions for DOS 3.0

A database engine is at the core of all these DMSes. In the case of SoftSolutions for DOS, the database engine is designed for text search and retrieval, making this DMS well suited for managing purely textual documents. Some other systems are built on standard database engines (e.g., PC DOCS uses Btrieve) that may not be as good at handling pure text.

SoftSolutions for DOS focuses on indexing and search technology. It has a rich syntax for wild-card and Boolean searches. With one command, the program looks across profile fields and examines the text of every document in the database to find a particular word. In contrast, using PC DOCS, you would have to specify the search fields separately. SoftSolutions' indexing and SpeedSearch tools are exceptional.

SoftSolutions for DOS is menu- and form-driven (see screen 2). Most of the fields in the forms have associated tables that you can query. For example, the Document Type field in the profile search form has an associated table. If you don't know which document types are available to you, the F1 key lets you scroll through the table and pick a type. When there is no associated table, there is a help screen.

This system is customizable. Not only can you limit different users to the document types they can access, but you can also create different menus and query screens for different users. For example, a customer may be able only to view the documents relating to a project and not be able to modify anything; a document librarian may be able to access everything and even check documents in and out but not be able to change anything; and a document editor may be given privileges to add, delete, and modify documents in only a few document types. The administrator defines what users can do and what their menus show.

The administrator can also add new document types on the fly. SoftSolutions for DOS can launch any application or batch file based on the information in the document profile. You can define any kind of document profile as well as different user profiles, each with its own menus and available resources.

As you locate documents, you can select (i.e., mark) the ones you want to send to an application. As with some other DMSes, you can launch the appropriate application programs for editing and viewing the documents that you have indexed with this system. "Mark and launch" is the system's facility for taking a document out of the SoftSolutions archives and bringing it into another application.

SoftSolutions for DOS can operate in a heterogeneous network with Unix and DOS/NetWare servers. It even works in a WAN, dialing up remote machines and checking out documents on remote sites. This means that the document base can be completely distributed across several networks. This is a capability to consider if your business has scattered offices that need to share information.

Activity accounting is a strong feature of SoftSolutions for DOS. It not only reports on the current document status, archival state, and so on, but it also keeps track of every time the article is edited, copied, or even previewed; which user initiated the activity; and when it occurred. There is also a built-in work log and accounting system that includes a report writer. Each document type and operation can have an associated fee. This greatly facilitates accounting in law firms.

As you would expect from the fact that its underlying database is designed for full-text indexing and searching, SoftSolutions for DOS excels at finding documents. The program addresses most major issues in document management but has a few shortcomings. For example, although you can pick and choose the layout of the query and report screens, you cannot remap the keyboard, which WordPerfect strongly influences.

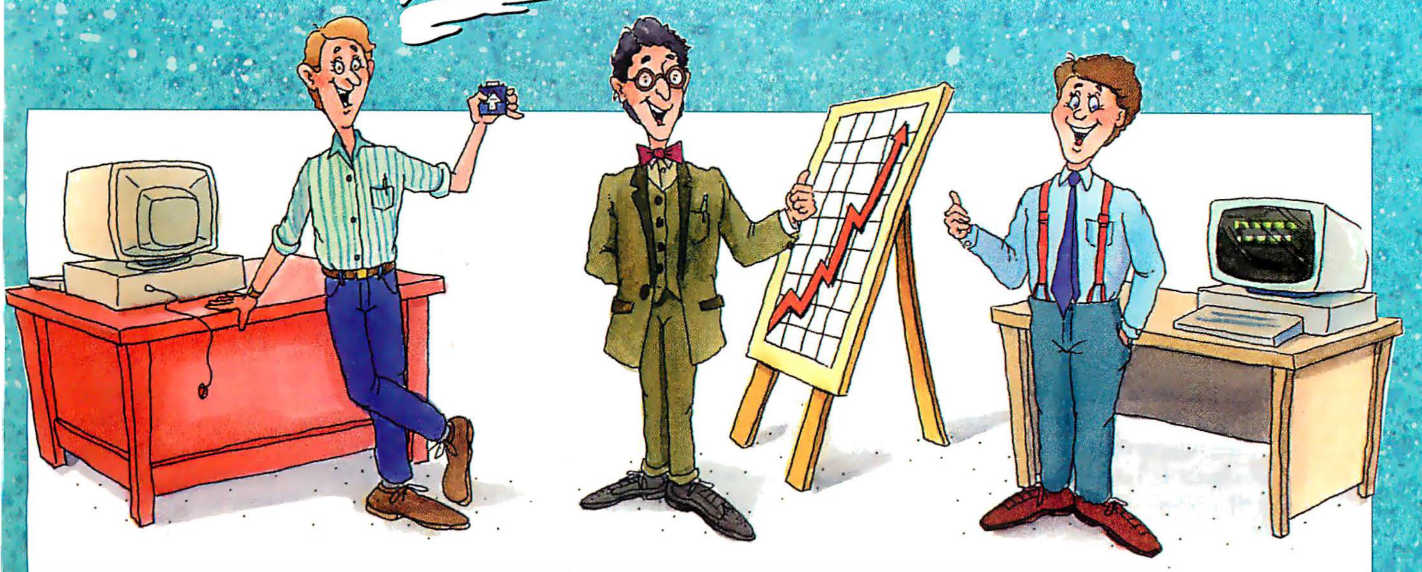
While you can define user privileges, you cannot define a work flow for a document type. You can maintain separate versions of a document but only as separate, full-size files. If you want to compare versions, you can use a third-party program, such as Jurisoft's CompareRite. You would mark the files you want to compare and then launch the document-comparison application. You can mark up to nine files at a time.

You can configure the menus, but even the default menus lack clear organization. They are very complex and require too many key presses to do simple operations, such as viewing the next document in a list.

The document viewer is not intelligent enough to recognize when a document is not a piece of text; it simply views all files as if they were textual documents. As with PC DOCS, if you want to look at an image file, you have to resort to using a third-party viewer.

SoftSolutions has an add-on module, the Image Manager, that lets you link a

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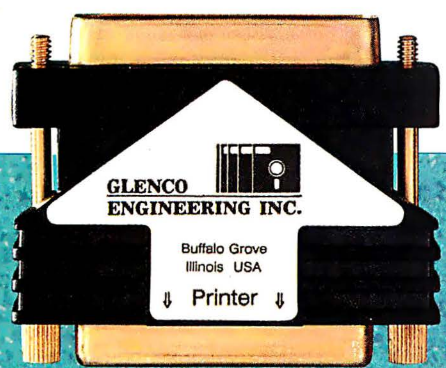
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Tools for Lassoing the Paper Cyclone

D. BARKER

There's a scene in the film *Brazil*, set in a dim, information-crazed future, where the Robert De Niro character is literally engulfed in a swirling cyclone of paper. If you've had days at work when you thought this was about to happen to you, you probably need a document management system.

There are now dozens of products that can help you manage images and text. They all provide tools for receiving electronic data, filing it, and then finding it pronto. The brief descriptions that follow will point you toward the product that's right for your situation.

BASISplus

Document management for the Fortune 500, BASISplus (from Information Dimensions) can be simplistically described as a comprehensive set of tools for searching and retrieving compound documents in a relational database. Documents can consist of mixed objects—text, graphics, alphanumeric characters, sound, and video—and can come from almost any application or device. Documents can be huge: up to 8000 sections, each holding 128 million characters. The system is noted for its advanced search-and-retrieval functions, including concept, proximity, and "sounds like" searches.

BASISplus is not the sort of thing you throw together over the weekend (the manuals stack 3 feet high). The system runs on IBM mainframes, DEC VAXes, and Unix machines, such as Sun Microsystems' Sparcstations, the HP 9000, the Bull HN series, and Unisys 6000. Front ends for searching and viewing are available for ASCII and EBCDIC terminals and for PCs running Windows. Prices range from $2500 to $179,000. According to a Datapro report, even users who criticize parts of BASISplus remain impressed by what it can do.

BRS/Search

A system from BRS Software Products, a company specializing in on-line research databases, BRS/Search excels at the fast finding of needles in haystacks. It is used by businesses that generate tons of text, including newspaper publishers, law firms, and government agencies. No matter how big the database, BRS/Search can retrieve documents in 5 to 10 seconds, according to the company.

The software does full positional indexing whenever a document is loaded into the system (i.e., it indexes each word in terms of its location within a sentence). You can search for words, phrases, or concepts. BRS/Search can handle just about any type of document, from common word processor files to compound documents. Security functions let the administrator hide not only documents but specific words as well.

Although BRS/Search lacks imaging functions, you can link it to an image management system. An API lets you integrate BRS/Search's retrieval engine with other applications. BRS/Search runs under major operating systems, from MVS and VM to VMS and most variants of Unix, as well as DOS and NetWare. The company recently announced a Windows front end for searching and viewing documents. Prices start at $2500.

Desktop Document Manager

A combination of Windows-based software and a controller card, Desktop Document Manager (from Alacrity Systems) is designed to process documents that come in via scanner or fax. There are applications for scanning documents into files, receiving and sending faxes, and compressing and decompressing images.

The software is iconic. For example, you drag files to a file-to-fax icon or click on a scan-to-file icon. The hardware component is a card that holds a Texas Instruments 34010 (50-MHz) graphics processor, which Alacrity Systems says speeds up printing time and raises print resolution to 600 by 300 dots per inch. Alacrity estimates that as many as 500 document images can be compressed into 10 MB of hard disk space, making this system a good solution if storage resources aren't plentiful. The price is $1995.

Document Administrator

Interpreter's Document Administrator falls into the same basic category as PC DOCS and SoftSolutions. This DOS-based program indexes and archives text, tracks revisions, prevents simultaneous editing, and lets you search for document profiles or particular words, or use wild cards and Boolean operators. Profile cards, which provide information on every document entered into the system, are extensive (providing up to 38 fields) and very flexible; the administrator can set them up to fit any situation (i.e., design it so that some fields have to be filled in). You can work within your regular applications and then send only the files you want to the document manager.

Document Administrator currently lacks the handsome interface of more graphical products, but its menus are straightforward. It works with NetWare, Vines, Etherlink, and other DOS-based LANs. It costs $2495 for up to 10 users.

FilePower

You can tailor Optika's modular imaging system, based on Windows, to fit your situation, whether it is one user or 500. Software modules include ImageFiler—for scanning, indexing, storing, and retrieving image documents; DataFiler—for doing those same things to text rather than images; ImageFinder—a network package for retrieving and printing documents; software for

managing various optical disks; FaxServer—for sending and receiving faxes; TransAct—for pulling data from mainframes, minicomputers, and other PCs; communications software that allows remote access; and ImageEngine Development Kit—for customizing the system, integrating it with other applications, and linking it to external databases.

The system works with major LANs. Prices run from $7500 to $100,000. Kenwood USA, a big audio company, is using a FilePower system to process and store warranty claims and invoices, replacing microfiche with optical disks.

ImageFast

A Windows-based imaging system with work-flow and text-indexing modules, ImageFast (from Benson Computer Research) uses the folders-in-file-cabinets metaphor. As with Keyfile, you can drag a file onto an icon to initiate actions such as sending a fax. Although it is image-oriented, the program has features for handling text, including an OCR (optical character recognition) module that can extract text from an image and save it as an ASCII file or flow it into specified fields of a form (extracted text can be automatically indexed). Users can set up data and query forms. An API allows developers to plug in their own modules or integrate the system with other applications.

For businesses that use lots of forms or faxes that need to be stored and quickly retrieved, ImageFast could be an excellent solution. A five-user LAN (NetBIOS) version starts at $9500; OCR, text, and work-flow modules are $650, $500, and $750, respectively.

Imagic

An image management system that runs under Windows, Imagic receives scanned and faxed pages and files them in an ISAM (indexed sequential-access method) database. The Westbrook Technologies' system is designed for people who work with images, whether they are drawings or forms, rather than for people who handle lots of text; however, the software can store and index any user-selected text on a page.

The program accepts TIFF and PCX files but converts them to its own proprietary format. Westbrook emphasizes that its approach allows you to use hardware you've probably already got installed. For workgroups, Westbrook's ImagicLAN lets multiple users simultaneously access images on a server. It works with popular PC LANs. Imagic is $895; the LAN version is $1895 per server, with unlimited users.

KIPP

The KIPP (Kofax Image Processing Platform) family of PC products turns paper into digital documents and stores them in a library. There's software and hardware to control the scanning and storing of documents, software for printing or faxing documents, and software for retrieving images across a network. For faster retrieval, decompression, and display, Kofax offers hardware engines (AT or Micro Channel boards).

KIPP also includes a display controller geared toward handling images, a document display system, and software for quick printing under Windows (if you must have paper). The KIPP Developer's Toolkit, available for DOS, Windows, OS/2, and Unix, lets you create applications that tie into Kofax software and hardware. KIPP is supported by a number of image management systems, including Keyfile, Imara, Imagic, and FilePower. Prices for the scanning/printing board start at $2400; display boards start at $1000.

MARS

Micro Dynamics' MARS (Multiuser Archival and Retrieval System) is a rarity: a heavy-duty document-imaging solution that's based on the Macintosh. Built on a client/server model, MARS converts scanned pages into image files and then stores them on optical devices.

The company also has a text search-and-retrieval program called FreeForm, which will hunt for words on every Mac on the network; Micro Dynamics claims that FreeForm will find every occurrence of a word within 500,000 pages of text in 5 seconds. An API called MARS Shuttle offers tools for customizing the system and integrating it with other applications. MARS sites include paper-laden companies such as Motorola, McDonnell Douglas Missile Systems, and the legal department of Ernst & Young. The single-user setup, which includes a Mac Quadra, a printer, a scanner, and the software, is $30,000. The network version starts at $70,000.

NCR DMS

This is very serious document management. NCR describes its DMS as "a general-purpose imaging system" geared toward businesses with a high volume of paper transactions (e.g., claims, applications, records, and orders). It provides data-entry, storage, search-and-retrieval, work-flow automation, and relational database functions. NCR recently added a module that recognizes handwritten numbers. DMS can use AT&T's Interspan frame-relay technology to allow access to images across a WAN; thus, NCR's office in Munich can view files on the server in the New York headquarters.

DMS runs on NCR's System 3000 multiprocessor computers. Prices start at about $800,000 for a setup that includes a server, 20 workstations, scanners, optical storage devices, and laser printers.

Team Document Library

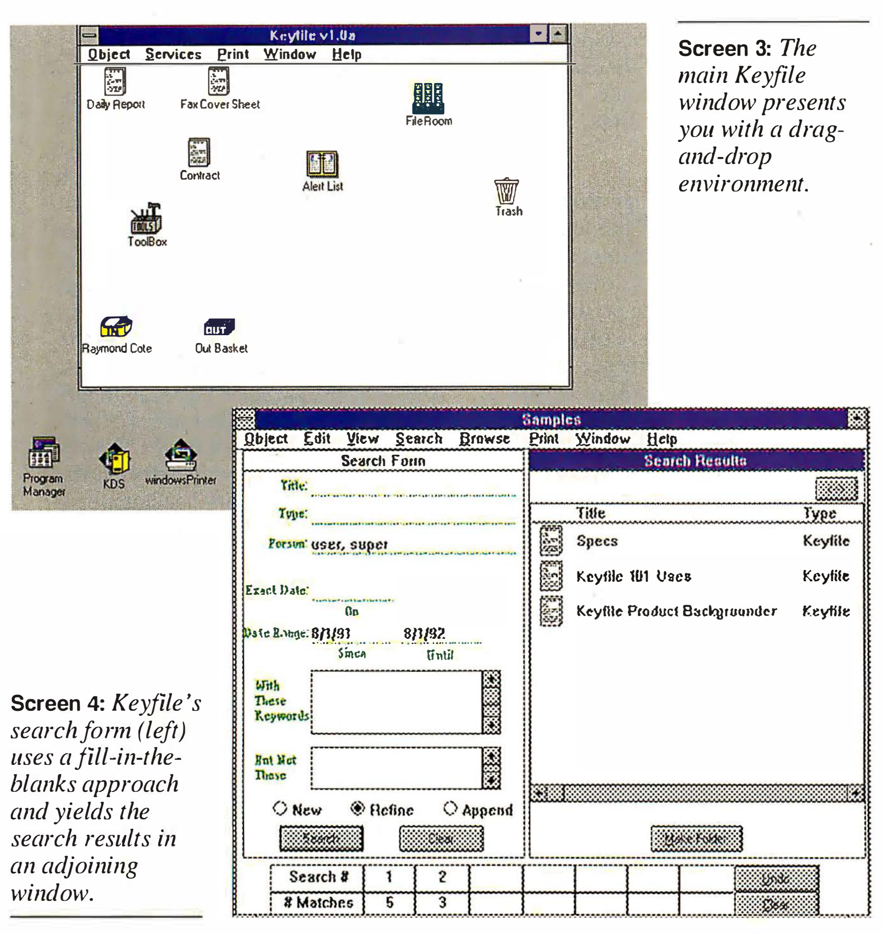
Aimed at departments that need to share a collection of compound documents, DEC's Team Document Library can be accessed by users of Windows-based PCs and Macs across a DEC Pathworks LAN. The system is based on Information Dimensions' BASISplus, powerful search-and-retrieval software built on a relational database. The system offers check-in/check-out control and a good set of search tools. Documents can come in from almost any source. Users can work with their regular word processor and other applications.

The system runs on a MicroVAX 3100; client machines need to be at least 386s or Mac IIs. Prices for the Windows version start at $59,950 for 20 users. Prices for the Mac version were not set at press time. The latest piece in DEC's Document Factory offerings, Team Document Library reflects the company's strides in integrating heterogeneous systems over a network.

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graphic to a text file. If you call up a document associated with an image, the program lets you know the image file is out there and tells you where it is.

Overall, the performance of SoftSolutions for DOS is good, and it's flexible enough to fit many businesses, but the user interface is far from intuitive. A Windows version is about to be released, but basically it just replaces the character-based menus and forms with Windows-style versions. SoftSolutions for DOS's underlying engine is excellent; what the program needs is an intuitive interface more like that of Keyfile.



Screen 3: *The main Keyfile window presents you with a drag-and-drop environment.*

Screen 4: *Keyfile's search form (left) uses a fill-in-the-blanks approach and yields the search results in an adjoining window.*

Keyfile 1.0a

A client/server application based on Windows, Keyfile can handle images and text. The program recognizes three page types: ASCII, TIFF, and "container pages." Container pages consist of data generated with another application (Word for Windows, for example). The data is kept on the Keyfile document server; when a user wants to view or edit that data, it's passed back to the application used to create it. The program lets you mail, store, and archive any type of file. The system architecture permits file viewers to be added, and the company says that it is working on new viewers for the most popular program formats.

At its simplest, the Keyfile environment consists of a single document server connected to multiple network clients. Although you can run a client and a server on the same computer, the server software is usually placed on a dedicated machine. In our test setup, we ran Keyfile on a pair of Dell 486D/25 machines using NetBIOS to communicate over NetWare. Our NetWare server was a Compaq Systempro. The program requires a Windows-capable PC with at least 3 MB of RAM; the server has to be a Windows or OS/2 machine with at least 4 MB of RAM.

You provide system services, such as printing, scanning, and OCR (optical character recognition), by adding specialized servers. The servers can reside on the central server machine, or you can install them on individual computers. The company recommends that you place compute-intensive services, such as the Calera OCR engine, on dedicated computers to ensure the most rapid throughput. However, if cost is an overriding consideration, you can place as many servers as you need on a single computer; you just have to be prepared to accept slower performance.

The main Keyfile window (see screen 3) presents you with a drag-and-drop environment. For example, dragging a document icon from the upper left corner of the screen onto the Out Basket icon automatically brings up the outgoing mail form. (A container page cannot be printed or faxed by dropping the document icon on the print or fax icon.) Likewise, dragging a document onto the File Room icon files the document away for future reference. The Application tool lets you place icons in your work area that you can then click on to launch DOS and Windows programs (or you can drag a document onto an icon to launch an application).

Original documents can come from many sources. They can be imported from existing files, scanned through an integrated scanner server, or received via a fax server.

Once a document is added to Keyfile, you can annotate it with text, graphics, and dictation (using a card like Creative Labs' Sound Blaster). Each annotation, which appears as an icon, is tagged with the name of the user who created it. Annotations can be hidden and viewed on a user-by-user basis. OCR data extracted from the image also appears as an annotated icon.

A Keyfile document has an associated profile that contains the title, creator, creation date, file type, and description. The profile also contains two sets of keywords. You enter one set of keywords when profiling the document. Keyfile extracts the other set from the text of the document (if it is ASCII text) or from the attached OCR data. Keyfile does not let the administrator predefine a set of words for the document type, description, and keyword list, so users can enter any information they choose in these fields. Unfortunately, this opens the way for the entry of misspelled or unique words.

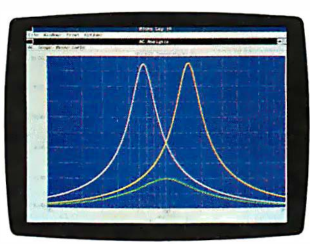
Document retrieval is simple: Keyfile presents a simple search form, as shown in screen 4; you fill in the form with the appropriate information and press the search button. You can refine the results further through additional searches. You can also undo the result of your last search operation if you find that the results are too limited. A Browse option lets you scan through the document profiles sorted by title, type, creator, or date. Within the search window, you can see a list of any

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keywords you've entered. After you select any of these keywords, Keyfile puts them into the search window and runs the search.

You can have any number of filing areas active in your Keyfile work area. You can select a single file cabinet or all file cabinets to search through. If you wanted to "find everything we've ever done with the Bilbo Baggins Travel Agency," you would go into the File Room menu and tell the program to search through all the cabinets.

The isolated computer is becoming a rarity in today's office. Most likely, your computer and your work need to be coordinated with many other people. Keyfile provides several basic communications options. Documents can be sent and received via fax, internal Keyfile mail, standard Windows E-mail servers, MHS Communication Server, and even printed and shipped via the U.S. Postal Service.

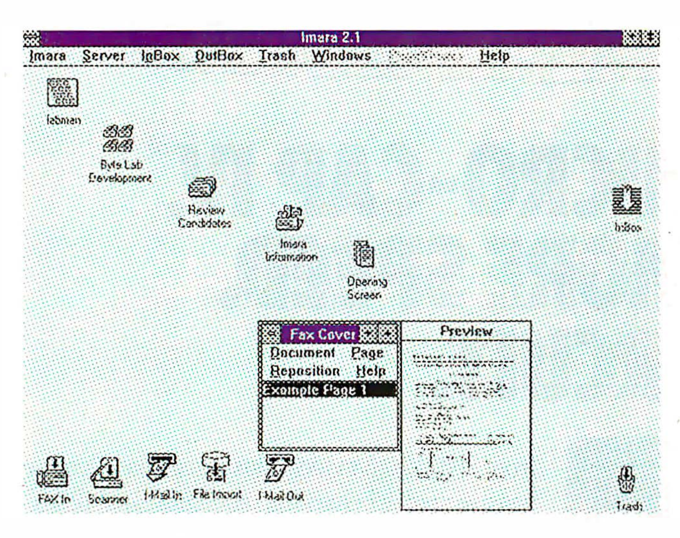
Of course, it is easy to lose track of documents as they move around and are shipped from person to person. The JobMaker tool can help keep track of the progress of of documents by creating work-flow Jobs. Each Job consists of a series of steps detailing who should be sent a specific document or set of documents. Jobs can automatically distribute documents to mailing lists and then wait for responses. If responses are not received within a defined period of days, you receive a notice that the step is not completed. In fact, Jobs can notify everyone involved in a project that the step was not completed.

Keyfile is best at tracking and filing static documents, not documents that frequently change. Keyfile does not automatically maintain different versions of a file. If files change, you must keep different versions as distinct documents. Keyfile is, however, prepared to manage large amounts of data. It supports several popular jukeboxes, as well as single-sided WORM drives.

One important aspect of Keyfile is the Koala (Keyfile Open Access Layer) interface. Koala is a scripting language that you can use locally from the Keyfile environment or externally through DDE. Although the ability to construct scripts is important, the ability to control and be controlled by other applications is central to Keyfile.

Keyfile is sold only through independent resellers, who typically use it to build customized file management systems. Although many customized environments are constructed totally within Keyfile, the ability to rapidly construct a Visual Basic front end to the Keyfile engine lets vendors quickly design and deliver customized vertical applications.

Keyfile is still a young product in need of maturity, but its user interface is simply the best of any document management package we've seen. We like its style of electronic office, with its use of folders, cabinets, and other intuitive elements. The program needs support for more document types and better searching tools to compete with strong search-and-file engines like SoftSolutions for DOS and PC DOCS.



Screen 5: *Imara's desktop depicts documents and activities as icons. The icons along the bottom of the screen represent methods for adding and transmitting documents to and from the system. In the foreground is a preview of a page to be used as a fax cover sheet.*

Imara 2.1

Imara from Imara Research is a client/server application based on a SQL (Structured Query Language) database. The client versions we evaluated ran on OS/2 Presentation Manager and Windows 3.1. The Imara environment consists of a SQL Server that maintains document-tracking information. The actual documents are not stored in the Imara system but are kept on network drives accessible to users through remote log-in. Index information is stored in the SQL database. In our test setup, we placed the Imara SQL Server and document-storage directories on an AcerFrame 3000MP; the Windows 3.1 client was on a Dell 486D/25. The Windows and OS/2 PM interfaces are similar.

To use Imara, you need an OS/2-compatible network, a SQL database server (Microsoft SQL Server, IBM Database Manager, or Oracle Server), and Windows workstations (386s or 486s) with at least 6 MB of RAM (8 MB on the server). You also need a scanner and probably some optical storage.

Screen 5 shows a typical Imara desktop. The icons along the bottom of the screen represent the various methods through which documents can be added to and transmitted from the system: fax, optical scanner, Imara E-mail, printer, and file import and export. The trash can holds documents for discarding that haven't yet been wiped from the system. (You can hide all these icons from view when you're not using them.) The desktop presents a drag-and-drop interface. You can move documents, in Mac style, by dragging them from folder to folder. You mail or discard documents by dragging them to the appropriate icon.

This drag-and-drop ability, while useful, is problematic. Contrary to what you expect with this sort of interface, you cannot drag and drop documents that are displayed as icons on the desktop. In our opinion, this is a serious bug. Since you see a nice interface with icons and the documentation states that you can drop documents on icons to mail or print them, you simply assume that this process is possible from the desktop. You can drag a document to the fax icon, but once a document is left on the desktop as an icon, you can't. The first time we encountered this problem, we spent half an hour trying to determine what we had broken. It took a call to Imara's technical-support group to learn that we hadn't broken anything.

Imara arranges documents into a rather rigid hierarchical structure. At the highest level are servers. Each server may contain multiple sets. Sets contain categories, which in turn hold folders. Documents are stored in folders. This hierarchy cannot be circumvented. You must place documents in folders; you cannot store them directly in a category. This means that you must dig down through four layers before finding documents. Although you can prevent

the intermediate levels from displaying on your desktop, switching from one folder to another requires a lot of activity. Imara does provide a shortcut. Selecting Document Finder from the menu lets you search through all the folders.

The documents that Imara handles best are faxes and scanned pages. Although it can manage and view TIFF images, Imara defaults to storing image documents in CCITT Group 3 or 4 fax compressed formats. The default scanner driver for the HP ScanJet or ScanJet Plus produces CCITT formats. Imara also lets you store and view ASCII files and faxes. (The company says version 2.2, not ready in time for this review, will let you fax text documents.) Currently, the program supports only the GammaLink GammaFax fax board. Release 2.1 allows you to launch applications that let you view and manipulate document types that Imara cannot directly view.

Importing previously created documents is time-consuming. You start by selecting the New Document option in the File Import tool. Then you open the document, create a new page (either text or image), select the file you want to import into this page, and close the page. You then add access and profile information to the file through two more dialog boxes. If you want to import large numbers of documents, you have to use Imara's script-like language, called IXL.

Because Imara is based on a rather serious, industrial-strength database, you would expect its searching capabilities to be pretty sophisticated. Surprisingly, they are rather mundane. Searches, called *queries* in Imara, are performed at two levels: query by keyword and query by form.

A query by keyword compiles a list of documents matching keywords, action dates, and document priorities. You enter all these profile values manually when you create a document. A Quick Keyword feature lets you select keyword phrases from a pick list. This helps to ensure that you enter keywords consistently. The scope of the keyword search is determined by the level at which you start the query. Starting a query from a folder searches only the files in that folder. Starting a query from a set searches all documents in all folders in all categories contained in that set.

Associated with each Imara folder is a form, which the user or the administrator defines, that describes the type of document located in the folder. A query by form searches all the information associated with each folder in a category and returns a list of folders that match the search criteria.

Imara's solution to document archiving is to let users move files to optical storage devices and take them off-line. You can move categories, folders, and documents to archive sets.

Work-flow and workgroup options are also lacking. Although Imara contains integrated fax and mail services, it cannot track documents sent to groups, determine if tasks are completed, or alert you when task completions are overdue.

Imara has many little quirks to trip the unwary user. Some of them (e.g., the ability to drag icons and drop them on destinations, which even surprised some Imara personnel) are major problems. Others are minor annoyances. For example, the Windows menus do not stay activated when you click on them with the mouse; instead, they act like Macintosh menu bars and disappear when you release the mouse button. This feels wrong even if you are a frequent Mac user, because you are expecting normal Windows behavior.

The program's dependence on SQL

Server means that response times are slow. We ran Imara on some fairly powerful systems and still spent a lot of time waiting for responses to button pushes and menu selections. Imara's worst problem is that the interface looks as if it should be intuitive. You start work on problems with certain expectations but often receive surprises. Imara is a good concept that needs some polishing.

Final Sort

All the products we reviewed here have impressive features. They also have weaknesses. If we could put together our dream DMS, it would combine the excellent interface of Keyfile with the sophisticated indexing and searching technology of SoftSolutions for DOS. Unfortunately, it is not yet possible to purchase that product in one box.

If you want a DMS primarily for handling image files—either drawings created with a PC or pieces of paper turned into digital images—Keyfile is a good solution. Its interface is creative and consistent, and it takes advantage of a graphical environment; it's convenient to be able to drag a document onto an icon and have the system fax that file for you. Also, the work-flow system is impressive and intuitive.

If you want a DMS primarily for handling vast amounts of text files, PC DOCS is a good solution. It doesn't have the extensive searching tools of SoftSolutions for DOS, which is more flexible and far-reaching, but its interface is more consistent, and it's generally easier to set up and use. PC DOCS is tied to Btrieve as a database, but in smaller work settings, that shouldn't be a limitation. Bigger companies, with greater database demands and the need to search across a WAN, might eventually be stifled by PC DOCS. They should have a look at SoftSolutions for DOS but also check out one of the Unix-based systems, such as Information Dimensions' BASISplus, BRS Software Products' BRS/Search, or DEC's new Team Document Library.

DMS software is such a complex subject that no review can guide you unerringly to the system that's right for you. We have simply tried to give you some criteria to go on when evaluating a DMS and considering a possible purchase. ■

Raymond GA Côté is a BYTE Lab editor continuing his 15-year love affair with computers as tools and toys. He has worked in the industry designing interpretive languages and user interfaces. He can be reached on the Internet at rgacote@bytepb.byte.com. Ben Smith is a BYTE Lab testing editor and the author of Unix Step-by-Step *(Howard W. Sams, 1990). You can contact him on the Internet at ben@bytepb.byte.com.*

COMPANY INFORMATION

Alacrity Systems, Inc.
(Desktop Document Manager)
43 Newburg Rd.
Hackettstown, NJ 07840
(908) 813-2400
fax: (908) 813-2490
Circle 988 on Inquiry Card.

Benson Computer Research
(ImageFast)
7926 Jones Branch Dr., Suite 260
McLean, VA 22102
(703) 442-4545
fax: (703) 893-7499
Circle 989 on Inquiry Card.

BRS Software Products
(BRS/Search)
8000 Westpark Dr.
McLean, VA 22102
(703) 442-3870
fax: (703) 827-0686
Circle 990 on Inquiry Card.

DEC
(Team Document Library)
146 Main St.
Maynard, MA 01754
(800) 344-4825
(508) 493-5111
Circle 991 on Inquiry Card.

Imara Research Corp.
(Imara)
111 Peter St., Suite 804
Toronto, Ontario,
Canada M5V 2H1
(416) 581-1740
fax: (416) 581-1605
Circle 992 on Inquiry Card.

Information Dimensions, Inc.
(BASISplus)
5080 Tuttle Crossing Blvd.
Dublin, OH 43017
(614) 761-8083
fax: (614) 761-7290
Circle 993 on Inquiry Card.

Interpreter, Inc.
(Document Administrator)
11455 West I-70 North Frontage Rd.
Wheat Ridge, CO 80033
(303) 431-8991
fax: (303) 431-9056
Circle 994 on Inquiry Card.

Keyfile Corp.
(Keyfile)
22 Cotton Rd.
Nashua, NH 03063
(603) 883-3800
fax: (603) 889-9259
Circle 995 on Inquiry Card.

Kofax Image Products
(KIPP)
3 Jenner St.
Irvine, CA 92718
(714) 727-1733
fax: (714) 727-3144
Circle 996 on Inquiry Card.

Micro Dynamics Ltd.
(MARS)
8555 Sixteenth St., Suite 700
Silver Spring, MD 20910
(301) 589-6300
fax: (301) 589-3414
Circle 997 on Inquiry Card.

NCR Corp.
(NCR DMS)
1700 South Patterson Blvd.
Dayton, OH 45479
(800) 225-5627
(513) 445-5000
Circle 998 on Inquiry Card.

Optika Imaging Systems, Inc.
(FilePower)
980 Enchanted Way, Suite 101
Simi Valley, CA 93065
(805) 520-9060
fax: (805) 520-9895
Circle 999 on Inquiry Card.

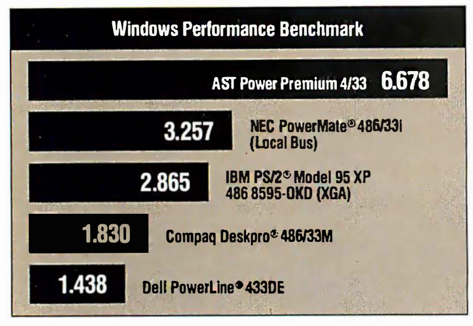
PC DOCS, Inc.
(PC DOCS 4.1)
124 Marriott Dr., Suite 203
Tallahassee, FL 32301
(904) 942-3627
fax: (904) 942-1517
Circle 1131 on Inquiry Card.

SoftSolutions Technology Corp.
(SoftSolutions for DOS 3.0)
Park View Plaza
625 South State St.
Orem, UT 84058
(801) 226-6000
fax: (801) 224-0920
Circle 1132 on Inquiry Card.

Westbrook Technologies
(Imagic, ImagicLAN)
P.O. Box 910
22 Pequot Park Rd.
Westbrook, CT 06498
(800) 949-3453
(203) 399-7111
fax: (203) 399-7137
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Workhorse Computers

The BYTE Lab puts 18 low-cost 386SX systems to the test

RICK GREHAN AND STAN WSZOLA

Over the past year, the 386SX has earned recognition as the workhorse of microprocessors, usurping the title formerly held by the now virtually abandoned 286. There are plenty of reasons for the increased popularity of the 386SX. It can run any software that a 386DX or 486DX can handle, albeit a little more slowly. All existing hardware that is compatible with the 386DX works with the 386SX. And, of course, 386SX systems generally cost a few hundred dollars less than comparably equipped DX machines.

In fact, attractively priced 386SX machines are everywhere, which makes it hard to know which way to turn when scouting out systems. To make your job easier, we've done a little of the legwork, reviewing an assortment of models from companies who advertise machines costing less than $2000. Many of the makers are mail-order companies, but a number of manufacturers who typically sell through resellers or dealers also are represented. Our list, while by no means exhaustive, is extensive and is a representative sample of the field.

In all, we looked at 18 386SX computers: the AcerPower 386SX, the Acma 386SX/25, the Addtech Research SlimPro 386SX-25, AMAX Engineering's 386SX-25, Ariel Design's 386SX-25 Cache, Cardinal Technologies' PC10, Club American's Eagle 325SX, CompuAdd's 325SC, Dell Computer's System 325SX, Duracom Computer's Desksaver 386/25SX, Gateway 2000's 25MHz 386SX, JCC Systems' 386SX-25, NEC's PowerMate SX/25i, PC Brands' 386/SX-25, PolyWell Computers' Poly 386-25SX, Tandy's 2500 SX/25 HD, Tangent Computer's 325s, and the Wyse Technology Decision 386SX/25C.

In an attempt to provide a level playing field, we requested that each manufacturer supply a system with a 386SX running at 25 MHz, 4 MB of RAM, a 387SX math coprocessor chip, 80-MB hard disk drive, VGA adapter, VGA monitor, and a mouse. All of the review units met these specifications; some far exceeded them. As we opened up the machines, poured over spec sheets, and ran our battery of benchmarks, differences in both price and performance became apparent (see the features table, "25-MHz 386SX Desktop Computers," on page 226).

The Inside Story

At the heart of every 386SX machine lies an 386SX processor; chances are that processor will carry the Intel or American Micro Devices label. As the features table reveals, Intel maintains the edge when it comes to the number of CPU chips sold.

BYTE ACTION SUMMARY

- **WHAT 386SX SYSTEMS ARE**
  A 386SX processor retains all the capabilities of the original 386DX but employs a narrower 16-bit data path. The lower cost of SX chips makes it possible to provide low-end systems that still run 386-specific applications.
- **LIKES**
  For many mainstream applications, an SX system will do the job for less money.
- **DISLIKES**
  Systems based on a full-scale 386DX offer noticeably better performance and, in many cases, the price of SX systems is only $200 to $300 lower.
- **RECOMMENDATIONS**
  We recommend the PolyWell Poly 386-25SX and the Wyse Decision 386SX/25C. But you should seriously consider a 386DX if its price is right.

AMD has, however, become a strong contender, building its share to about 10 percent of the CPU market, in part by repeatedly bringing out faster-rated 386SX and 386DX chips ahead of Intel.

AMD took on Intel in mid-1991, introducing a 16-MHz 386SX chip to compete against Intel's 12-MHz processor. Intel countered by marketing 16- and 20-MHz 386SX chips, at which point AMD brought out its Am386SX/25 microprocessor. When Intel rolled out a 25-MHz 386SX chip, AMD upped the ante with its Am386SX/33. At the same time, AMD has priced its chips aggressively, forcing Intel to lower its prices and undoubtedly prompting the company's high-profile "Intel Inside" marketing campaign.

But in terms of performance, functionality, and reliability, neither company appears to have an edge: We noticed no difference between the AMD and Intel chips. The only way to tell which chip is inside a computer is by taking off its cover.

When it comes to math coprocessors, however, brand name may make some difference. Fully 10 out of the 18 test computers used the Cyrix FasMath 83S87 coprocessor rather than Intel's 387SX coprocessor. Our performance tests did not indicate any glaring advantage to using the Cyrix instead of an Intel (or AMD) math chip. In fact, most systems equipped with a Cyrix chip turned in LINPACK and low-level floating-point results on a par with systems running Intel chips. We should point out, however, that both of the systems that ranked highest in the scientific/CAD benchmarks—where a math coprocessor is most likely to provide the best performance boost—had Cyrix coprocessors. Interestingly, the extra kick won't cost you extra. A recent scan through several mail-order ads revealed that you can get Cyrix chips for about $20 less than Intel chips of equivalent speed.

The Compatibility Question

Backing up these computers' CPU and math chips are a host of other chips. In the bad old days, you had to worry about the "PC compatibility" of such chips. When clones of the original IBM PC first began to appear, BYTE reviewers routinely tested a system for compatibility to ensure, for instance, that a clone system's motherboard and BIOS would function just like the original PC's. Today it's a given that if a computer can run the BYTE low-level and application benchmark programs, it is compatible.

Our review systems used a wide variety of motherboard chip sets: OPTI, Chips & Technologies, Micronics, VLSI, Texas Instruments, Western Digital, and AMD. The systems also employed a variety of BIOSes from Phoenix, NEC, AMI, and other companies. We encountered no compatibility problems.

One big difference did strike us, however: the quality of the documentation explaining how to set up the various CMOS and chip-set features. The well-known brands, such as Dell, Gateway, and NEC included extensive documentation that made it easy to set up the systems for our benchmark tests. The instructions for other brands, such as the Addtech, covered only the bare essentials of system setup. (See the text box "A Carry-Along Alternative" for a closer look at this machine.)

Our recommendation? If you are inexperienced in system setup, stick with the well-known brands or have your dealer set up and explain the system to you.

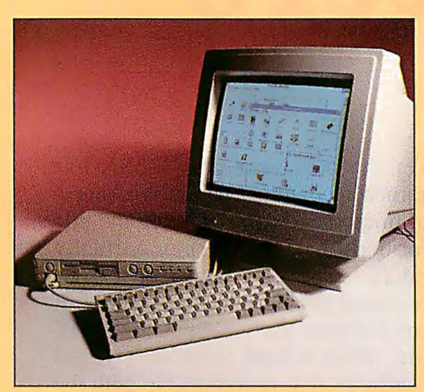
A Carry-Along Alternative

The Addtech SlimPro 386SX-25 is significantly different from the other 386SX computers in this product report. While the rest of the machines are strictly desktop computers, the SlimPro is a transportable computer in the tradition of the Ergo Brick and the Flytech Carry1: a system for users who want to take their computers with them but can expect to find a full-size keyboard and monitor at their destination (see accompanying photo).

The monitor-less SlimPro measures 11.5 by 10.75 by 2.25 inches and weighs 8.1 pounds, making it small enough to fit into a standard briefcase. Our review model packed a 25-MHz 386SX CPU, a compact 81-key keyboard, and list price of $425; with a 16-MHz 386SX processor, the SlimPro costs $325. Standard features include 1 MB of RAM (expandable to 16 MB), a 1.44-MB floppy drive, a VGA card with 1 MB of video RAM and an IDE controller for connecting an internal 3½-inch hard drive. As tested, with 4 MB of RAM and an 85-MB Western Digital hard disk, the system lists for $1106.

The SlimPro is configured to use a standard VGA monitor and any keyboard that has a standard DIN connector. The unit has two 16-bit, three-quarter length expansion slots. A VGA adapter occupies one of the system's expansion slots, leaving only one empty slot. This setup doesn't offer you much room for expansion, but you can upgrade the video card in the future, thus extending the working life of the computer.

Although built to travel, the SlimPro will fit right in on your desk. Its beige case and small size—just large enough to slip under a monitor—make it attractive enough for any office.



The Addtech SlimPro, a transportable computer similar to the Ergo Brick and the Flytech Carry1, lets you carry your computer from site to site and be able to plug in a full-size keyboard and monitor.

The SlimPro handled our benchmarks reasonably well, placing in the middle of the pack in almost all tests. It did not exhibit any outstanding characteristics, good or bad.

Like many low-cost computers, the system comes with a minimum of documentation. The user's manual is a slender 41-page booklet, and its instructions for setting up the unit using AMI's setup utilities is terse almost to the point of uselessness. Many of the setup options, for instance, are not explained at all.

The SlimPro is made for the person who needs a reasonably fast computer that can be transported easily. Its diminutive footprint and quiet operation make it very attractive.

Don't Forget the Memory

The other chips of paramount concern are memory chips. Now that so many users are running Windows, it is foolish to offer base configurations with less than 4 MB of RAM. Yet many manufacturers still market systems that come with only 1 or 2 MB of memory—apparently so that they can advertise artificially low system prices.

If you plan to run Windows on a 386SX, give your system the 4 MB of RAM it needs to run comfortably. Adding more memory will give it the necessary breathing room to work with high-end applications and should improve the performance of any system. With all these systems, boosting memory ought to prove relatively simple. All accept standard SIMMs in 1-, 2-, or 4-MB increments. Most can handle as much as 16 MB of RAM on their system boards, and the JCC Systems motherboard accepts as much as 32 MB.

Driving a Hard Disk

For storing information more permanently, the hands-down choice in a hard drive interface is the IDE standard. The IDE design offers simplified controller design, and much of the electronics resides on the drives themselves. The IDE interface also pairs good performance with low-priced drives. Widely available, IDE drives showed up in all 18 of the review units, and in many of the units the IDE controller was integrated onto the motherboard and attached to the drive with a single ribbon cable.

The former standard hard drive capacity of at least 40 MB is woefully inadequate when confronted with software packages that demand 5 to 10 MB for just a minimum installation. Those requirements don't even take into account the files you might generate in day-to-day work. The minimum configuration today should be 80 MB; 100 MB is a better lower limit for users who work with graphics images or multimedia. Although we requested systems with an 80-MB capacity, many of the manufacturers provided drives in the 100- to 125-MB range.

Access times ranged from 16 to 18 milliseconds; the drive's original manufacturers were more diverse: Maxtor, TEAC, Western Digital, Quantum, Seagate, and Conner showed up in the test systems. But hard drive makes and models are subject to change. Many computer manufacturers frequently switch drive models and brands if they can get a better price or if a drive they have been using no longer is available. Consequently, the drive specified in the features table may have changed by the time you order a system.

Looking at Video

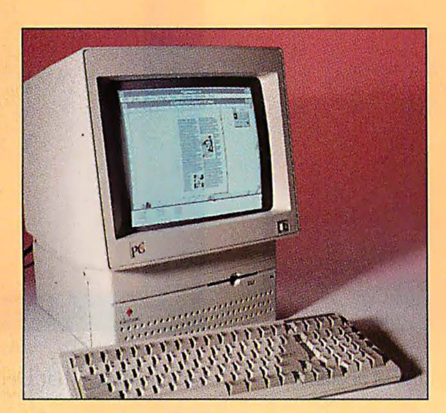
As with drive functions, many computer makers now are integrating video functions into the motherboard. This improves

Is It a Mac?

When we pulled the Cardinal out of its box, we thought for an instant that we were uncrating a new Mac clone that had been improperly substituted for the 386SX we requested. We haven't seen a PC clone with an integrated monitor for quite some time.

In truth, someone walking rapidly past this machine might mistake the Cardinal for a Mac SE. The Cardinal is about an inch bigger all around, but a Mac-like paper-white display and a 3½-inch floppy located in the same place as on Mac Classics and SEs (see accompanying photo). Although monochrome, the display can handle 64 shades of gray and is VGA compatible. (An included utility program lets you set the display to emulate any number of other monitor types: PC monochrome and Hercules monochrome, for example.) If you don't like black-and-white screens, the standard VGA connector around back will happily accept your favorite color VGA monitor.

Loosen two thumbscrews in the back and the monitor section slides off. Though the monitor remains connected to the motherboard by an umbilical of wires, the cables have enough slack that you can lay the monitor on its back behind the main chassis and do whatever work needs doing on the motherboard. Inside are a frightfully sparse



The Cardinal PC10, with its integrated monitor and compact design, looks more like a Mac than a PC. Unfortunately, its performance and price are not as attractive as its appearance.

motherboard and two horizontal 16-bit short slots that can hold boards as large as 4.2 by 8.8 inches. It amazed us that just a brace of VLSI chips—along with the CPU, of course—could provide two serial ports, parallel port, PS/2 mouse port, floppy and hard disk interfaces, and the VGA interface.

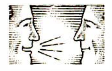
Expanding the Cardinal should prove easy; the math coprocessor socket (our Cardinal came with an Intel 387SX) and SIMM connectors are accessible. The system has room for only one 3½-inch floppy drive and one 3½-inch IDE hard drive, however. The system we tested contained an 80-MB hard drive; if your storage needs are more modest, a 40-MB version is available.

Our unit's operating system was Digital Research's DR DOS 6.0. Although we can't do a full review of DR DOS 6.0, we will say that all benchmarks ran without fail. We did have to modify some of the entries in our standard CONFIG.SYS file, but we made those changes easily with the help of the unit's documentation.

Unfortunately, the Cardinal's interesting look doesn't carry the day when performance is involved. On all our benchmarks, the Cardinal's scores were moderate to disappointing. Similarly, its price isn't cause for celebration; at $1299 it is neither a leader nor a follower. In addition, a 12-inch monochrome monitor is simply inappropriate for dealing with color graphics of even moderate resolution; this is especially true if you're running lots of Windows applications.

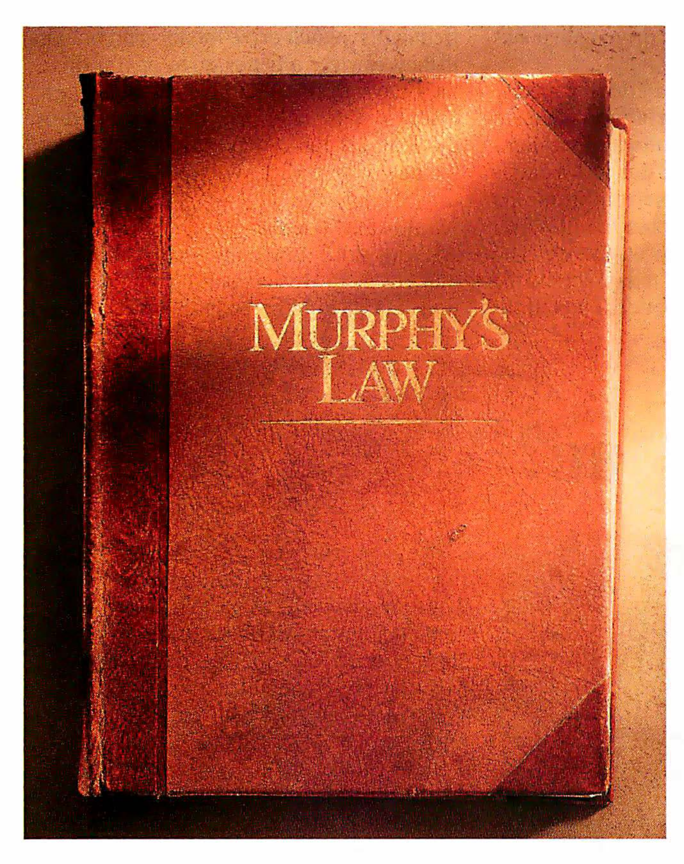
If a stylish and space-saving design is what you're after, then perhaps the Cardinal deserves scrutiny. Otherwise, it's likely your computing needs would be better served by other systems.

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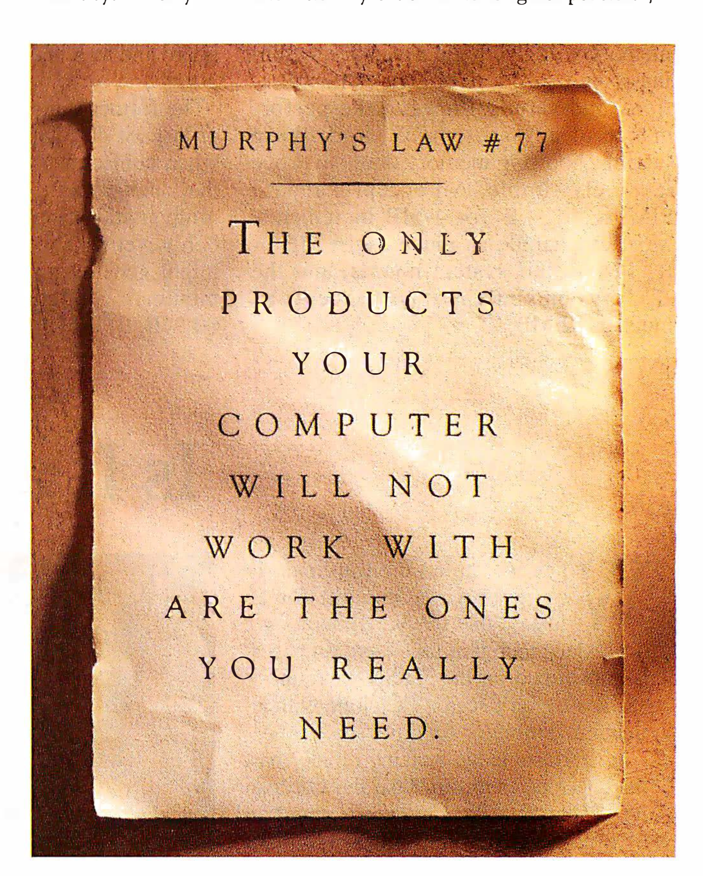


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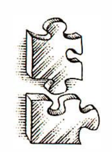
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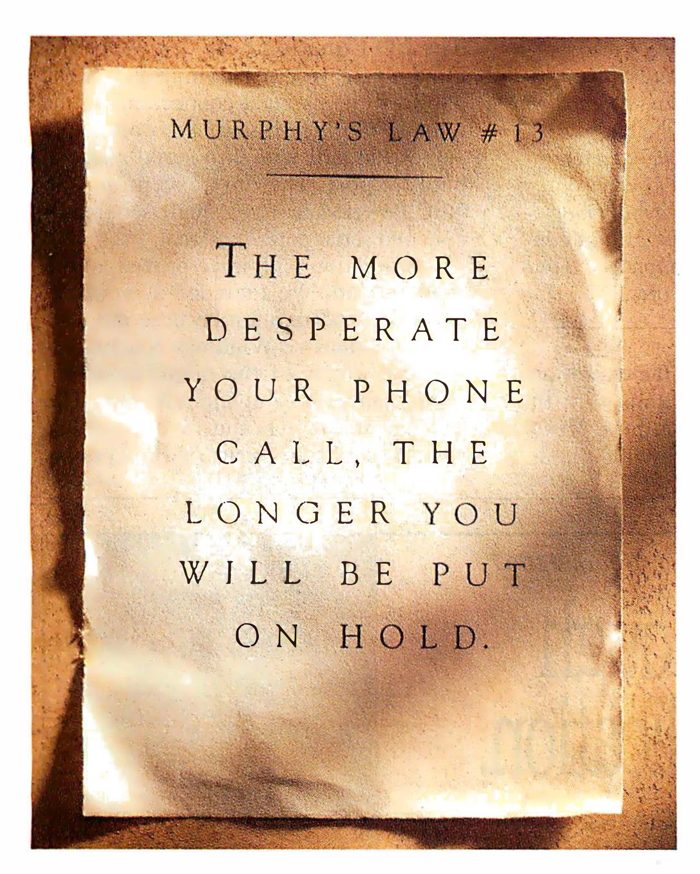


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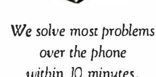
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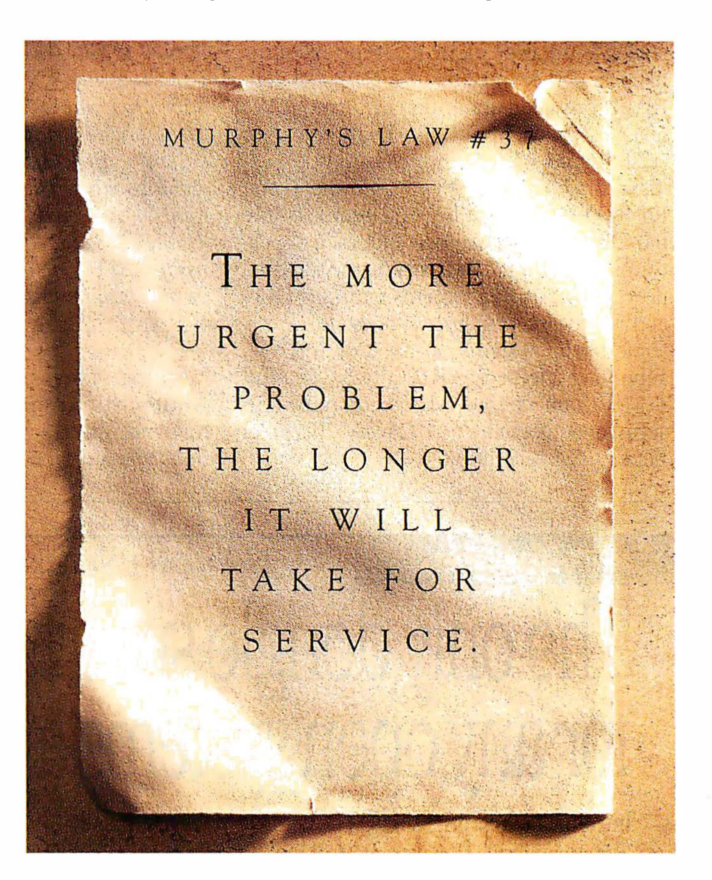
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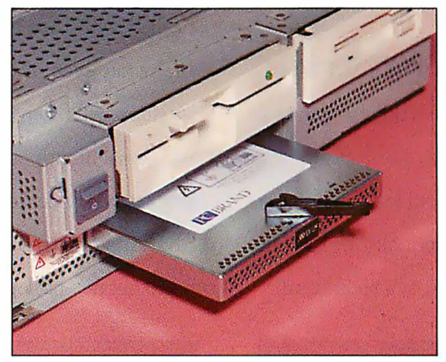
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video response time because data no longer must pass through the slower system bus. Unless the built-in adapter can be disabled, however, this approach forces you to accept the video adapter installed on the motherboard. That's a problem if you anticipate some day using higher screen resolutions than your original adapter allows. In that case, filling up an expansion slot with a video adapter doesn't seem like such a bad idea.

Whether you have integrated video or a separate adapter card, the type of chips used and the amount of VRAM (video RAM) provided are important. Among the test systems, Orchid and Diamond chip sets figured prominently. Only two systems, the NEC and Wyse, used the Tseng ET4000AX video chip set, which—like the Orchid and Diamond chip sets—performs well in video tests. We encountered no compatibility problems running DOS and Windows benchmark tests; however, some of the systems skimped on VRAM, supplying 256 or 512 KB, instead of a full 1 MB. You need 1 MB to display 256 simultaneous colors at 1024- by 768-pixel Super VGA resolution.



The PC Brand CPU module makes upgrading microprocessors a snap. Inside the cartridge are the microprocessor, coprocessor, cache, and a few support chips. The 9- by 11-inch system board holds the BIOS and main memory, the IDE controller, floppy disk controller, SVGA display adapter, and one parallel and two serial ports.

All the systems, with the exception of Addtech's SlimPro, came with their own noninterlaced monitors. Resolutions ranged from 640 by 480 pixels to 1280 by 1024 pixels, and vertical refresh rates ranged from 60 to 72 Hz (indicating the screens were redrawn completely 60 to 72 times per second). The best-looking monitor was the NEC PowerMate's optional NEC 4FG display. The most unusual video setup we encountered was the monitor integrated into the system box of Cardinal Technologies' PC10 (see the text box "Is It a Mac?" on page 217).

The I/O Equation

Of course, like all computers these 386SX systems need connections to the outside world. Most of the computers come standard with two serial and one parallel port. The only exception, the NEC PowerMate, has a single serial port; a second serial port is optional.

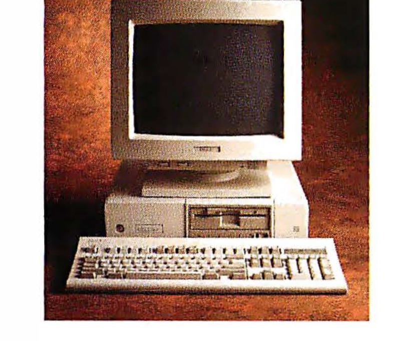
The situation with mice proved a little more varied. We included a mouse in our base configuration because our tests involve extensive Windows benchmarking, but a few of the manufacturers' base models do not include one. The most prominent brand of mouse was Microsoft's. Only four of the systems

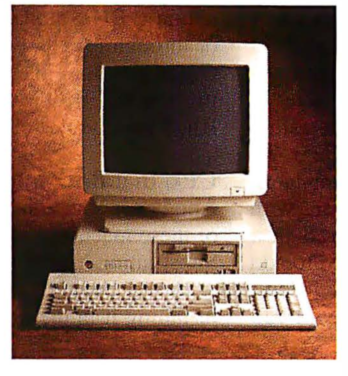
continued

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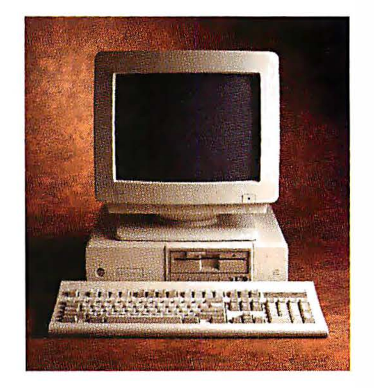
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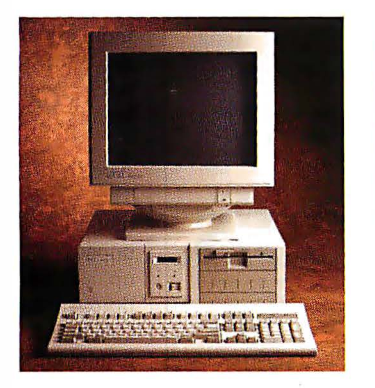


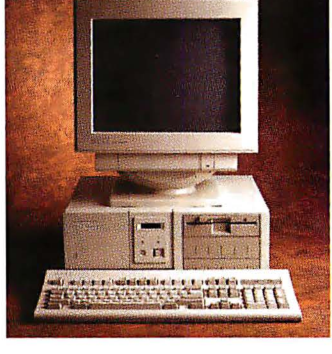
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- ONE FLOPPY DRIVE (3.5" OR 5.25")
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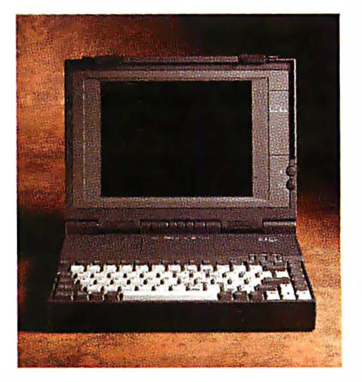
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provide mouse ports; all the others use a serial mouse, which takes up a serial port that you might someday need for another device.

NEC is alone in providing an interesting I/O feature on its PowerMate SX/25i. To keep up with changes in computer technology, NEC equips the PowerMate with an upgradable BIOS that is stored in a "flash ROM" chip. When you need to add new hardware or a peripheral not accommodated by your current BIOS, you can obtain a BIOS update disk from a dealer or through NEC's BBS. The *NEC User's Guide* gives complete instructions on saving the old BIOS and copying the new BIOS into the flash ROM chips.

CPU in a Box

Another innovation that shows up in two of these machines is a CPU upgrade path. Substituting a more powerful CPU usually means buying a new motherboard and installing it in the old case—clearly not a job for an inexperienced user. The PC Brand 386/SX-25's CPU module makes this process as easy as sliding in a floppy disk. The microprocessor module is a 6- by 7¼-inch metal-encased cartridge just ⅝ of an inch thick. Inside the cartridge are a microprocessor, coprocessor, cache (8 to 32 KB), and a few support chips, a design identical to that used for some of Tandon's desktop computers. The 9- by 11-inch system board holds the BIOS and main memory and the I/O circuitry, including the IDE controller, floppy disk controller, Super VGA display adapter, and one parallel and two serial ports (see the photo on page 220).

PC Brand offers a complete series of microprocessor modules, including a 386SLC-50 for $299; a 386/40 (with a 387 math coprocessor) for $499; a 486/SX-25 for $499; a 486/33 for $799 and a 486/50 for $1099.

As with many upgrades to existing hardware, this setup has a downside. Although you can increase the performance of the PC Brand, you get a smaller performance boost than you would if you purchased another computer designed around a faster processor. The upgraded motherboard still is configured to support the 386SX CPU, which has 16-bit data lines rather than the 32-bit lines provided by a 386DX or 486 chip.

Ace in the Hole

The AcerPower 386SX has a different sort of CPU upgrade option. When we first unpacked the machine, we naively set it up, verified that we had the proper portions of the BIOS shadowed, loaded the benchmarks, and began running them. The results knocked us back like the wake of a passing speed boat, leading us to conjecture that Acer had perfected the 100-MHz 386SX or that something unusual was afoot. The latter proved true. The AcerPower 386SX is equipped with an "overdrive" CPU socket, a special socket on the motherboard that accepts Intel's clock-doubling CPU. Indeed, when we ran The Norton Utilities, they reported that the machine contained a 50-MHz 486 CPU.

The AcerPower's CPU upgrade socket is special, indeed. If you have an AcerPower with a 386SX currently installed, you simply take the top off the case and plug in the 486 chip. That's it; the system automatically detects the new chip and the proper BIOS kicks in at boot-up. This is possibly the most painless upgrade we've seen. And Acer had "painlessly" upgraded the machine before shipping it to us. Painfully, we downgraded the machine to its 386SX level but not without noting that the

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- 8088/286/386 compatible
- Automatically switch between XT or AT
- One-year warranty

FKB4700 Fujitsu 101-key enhanced keyboard..**$79.95**
FK5001 130-key enhanced keyboard with calculator **89.95**
JE2018 32-key serial keypad **59.95**
K101 101-key enhanced keyboard (90-day warranty)..............................**49.95**

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- One-year warranty

JE1030 150 watt 8088................................**$69.95**
JE1030A 200 watt 8088 ....**89.95**
JE1036 200 watt 286/386 ....**89.95**
JE1038A 250 watt 286/386 ....**99.95**
JE1039A 300 watt 286/386 ....**149.95**

KaLok Hard Disk Drives

- 90-day warranty

KL320 20MB MFM hard drive..................**$169.95**
KL330 30MB RLL hard drive.......................**189.95**

Call for information on controller cards.

Hard Drives (IDE)

Conner IDE

- 8088/286/386 compatible
- Requires host IDE adapter
- One-year manufacturer's warranty

Part No.	Capacity	Speed	Price
CP3000	40MB	25ms	**$249.95**
CP30084	80MB	25ms	**399.95**
CP30104	120MB	19ms	**479.95**
CP3204	200MB	16ms	**699.95**

Controllers

IDE Disk Drive Adapter Cards

Standard Features:

- Interfaces two IDE hard drives to system
- One-year manufacturer's warranty



ADP20 16-bit hard adapter..........................**$29.95**
ADP20F 16-bit hard/floppy adapter **39.95**
ADP50 8-bit hard adapter **79.95**
ADP60 16-bit hard adapter with BIOS **79.95**
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Computer Service

- (2) Slotted screwdrivers: 1/8", 3/16"
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- (2) Nutdrivers: 3/16", 1/4"
- (2) Torque screwdrivers: T-10, T-15
- 14-16 pin IC inserter/straightener
- 3-claw parts holder
- Tweezers
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- Black vinyl carrying case

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- Masterpower switch and 5 auxillary switches for each outlet
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- Maximum spike volts: 6,000V@ 4,500A
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- One-year manufacturer's warranty

356KU................**$99.95**



Additional Internal Floppy Disk Drives

- One-year manufacturer's warranty

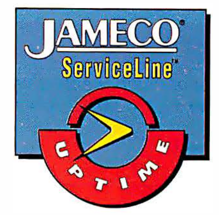
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JE1043 8088/286/386 two-drive controller.....**$49.95**
JE1049 8088/286/386 four-drive controller......**59.95**

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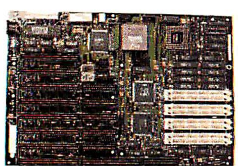
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Motherboards

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- Supports 64KB, 128KB or 256KB direct mapped cache RAM
- Six 16-bit slots and two 8-bit slots
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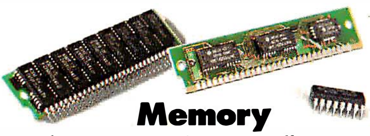
JE3633	80386 33MHz motherboard	$459.95
JE3633MS	80386 33MHz motherboard with MS-DOS 5.0 and Windows 3.1	579.95

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Part No.	Pins	Function		Price
41256-120	16	256K	120ns	$1.69
41256-150	16	256K	150ns	1.59
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511000P-10	18	1MB	100ns	5.49

SIPPs and SIMMs

41256A9A-10	256K SIPP 100ns (has leads)	$18.95
41256A9B-80	256K SIMM 80ns	16.95
421000A9A-80	1MB SIPP 80ns (has leads)	54.95

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Computer Cards



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JE1050A	8088/286/386 monochrome graphics adapter	49.95
JE1058S	8088/286/386 Super VGA	149.95
JE1060	8088 I/O	59.95
JE1062	88/286/386 RS232 serial (16450 UART)	29.95
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JE1065	80286/386 I/O	59.95
JE1075	8088 multi I/O w/floppy controller	69.95
JE1076	80286/386 multi I/O w/floppy controller	69.95
JE1080	8088 memory expansion half card	49.95
RAMQUEST	8088/286/386 Orchid 32MB memory card	169.95

Cables, Gender Changers, and Adapters





PPC6	6-foot parallel DB25-pin male to Centronics male printer cable	$8.95
PPC12	12-foot parallel DB25-pin male to Centronics male printer cable	11.95
SAT6	6-foot 9-pin serial DE9 female to DB25 male cable	5.95
25M10F	10-foot DB25-pin male to female cable extension	9.95
25M10M	10-foot DB25-pin male to male cable extension	9.95
GC25F	DB25-pin female slim line gender changer	4.49
GC25M	DB25-pin male slim line gender changer	4.49
AD925	DE9 female to DB25 male serial adapter	4.95
AD926	DE9 male to DB25 female serial adapter	4.95

Jameco Solderless Breadboards

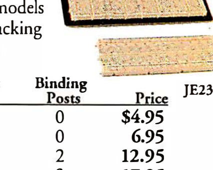
JE27

Jameco's long-lasting breadboards feature screen-printed color coordinates and are suitable for many kinds of prototyping and circuit design. Larger models feature a heavy-duty aluminum backing with voltage and grounding posts.

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Part No.	Dim. L" x W"	Contact Points	Binding Posts	Price
JE21	3.25 x 2.125	400	0	$4.95
JE23	6.50 x 2.125	830	0	6.95
JE24	6.50 x 3.125	1,360	2	12.95
JE25	6.500 x 4.25	1,660	3	17.95
JE26	6.875 x 5.75	2,390	4	24.95
JE27	7.250 x 7.50	3,220	4	32.95

Metex Digital Multimeters



M4650

- Handheld, high accuracy
- Measures AC/DC voltage, AC/DC current, resistance, diodes, continuity, and transistor current gain (except M3900)
- Manual ranging w/overload protection
- Comes with probes, batteries, case and manual

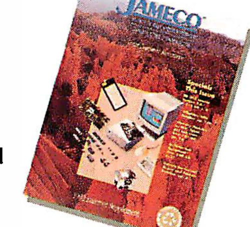
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M3800	3.5 digit multimeter	$39.95
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M3900	3.5 digit multimeter with tach/dwell	59.95
M3650	3.5 digit multimeter w/frequency & capacitance	74.95
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25-MHZ 386SX DESKTOP COMPUTERS

The mix of components a vendor supplies with its systems can change overnight. Make sure you know what you're getting before you buy. (● = yes; ○ = no; N/A = not available.)

Company	Acer America Corp.	Acma Computers	Addtech Research	AMAX Engineering
Model	AcerPower 386SX	386SX/25	SlimPro 386SX-25	386SX/25
Chips				
Brand of CPU	Intel	Intel	AMD	Intel
CPU upgrade	●	○	○	○
Brand of math coprocessor	Cyrix	Cyrix	Cyrix	Cyrix
Brand of motherboard chip set	Acer	OPTI	Chips & Technologies	OPTI
Brand of BIOS	Acer	AMI	AMI	AMI
Memory				
Standard RAM (DRAM)	2 MB	4 MB	1 MB	4 MB
Max. RAM (DRAM)	8 MB	16 MB	16 MB	16 MB
No. of wait states	None	None	None	None
Standard cache (SRAM)	N/A	N/A	N/A	N/A
Max. cache (SRAM)	N/A	N/A	N/A	N/A
Storage media				
Standard floppy configuration				
5¼-inch floppy drive	Optional	●	Optional	●
3½-inch floppy drive	●	●	●	●
Standard hard disk configuration				
Brand and model	Maxtor 7120A	Quantum LPS 120AT	WD CA280	Quantum LPS 120AT
Capacity	125 MB	120 MB	85 MB	120 MB
Max. hard disk capacity offered	2 GB	1.4 GB	1 GB	1.4 GB
Interface type	IDE	IDE	IDE	IDE
Caching controller	●	○	○	○
No. of drive bays	4	4	1	4
Monitor				
Brand	Acer	Impression Plus	N/A	Impression Plus
Color (C)/Monochrome (M)	C	C	N/A	C
Max. resolution	1024 x 768	1024 x 768	N/A	1024 x 768
Expansion slots				
No. of ISA slots	4	8	2	8
Proprietary slots	CPU upgrade socket	None	None	None
Standard interfaces				
No. of serial ports	2	2	2	2
No. of parallel/printer ports	1	1	1	1
Video adapter/Resolution	Super VGA/1024 x 768	Super VGA/1280 x 1024	VGA/640 x 480	Super VGA/1024 x 768
Standard VRAM	512 KB	512 KB	1 MB	1 MB
Brand of video adapter	ATI	Diamond	Customer selects	Diamond
Mouse included	●	●	○	●
Serial mouse (S)/Mouse port (MP)	MP	S	S	S
Game port	○	●	○	●
Power Supply (watts)	145	250	60	250
Bundled software				
MS-DOS 5.0	●	●	○	●
Windows 3.1	●	●	○	●
Other	Utilities	None	None	None
Warranty	1 year parts and labor	1 year parts and labor; on-site service	1 year parts and labor	1 year parts and labor
List Prices				
Standard configuration	$1295	$1195	$560	$1495
Review unit price	$2449	$1995	$1106	$1705
Review unit options	Ultra 15C controller with 2 MB of RAM, 200 MB hard drive, 2 MB of RAM	2 MB of RAM, 387SX math coprocessor, 120 MB hard drive	WD 80-MB hard drive, Cyrix math coprocessor, mini-keyboard	120 MB hard drive, Cyrix math coprocessor

Ariel Design	Cardinal Technologies	Club American Technologies	CompuAdd Computer	Dell Computer
386SX-25 Cache	PC10	Eagle 325SX	325SC	System 325SX
AMD	AMD	AMD/Intel	Intel	Intel
○	○	○	○	○
Cyrix	Intel	AMD/Intel	Intel	Intel
Micronics	VLSI	VLSI	Chips & Technologies or TI	VLSI
Chips & Technologies	AMI	AMI	Phoenix	Phoenix
4 MB	1 MB	2 MB	2 MB	2 MB
16 MB	16 MB	16 MB	16 MB	8 MB
None	None	None	None	None
32 KB	N/A	N/A	32 KB	N/A
32 KB	N/A	N/A	64 KB	N/A
●	○	●	●	Optional
●	●	●	●	●
WD CA280	TEAC SD380/H	Quantum LPS 105AT	Quantum LPS120AT	Quantum LPS52AT
80 MB	86 MB	105 MB	120 MB	52 MB
500 MB	86 MB	425 MB	1.2 GB	500 MB
IDE	IDE	IDE	IDE	IDE
○	○	○	○	○
4	1	4	4	3
Viewsonic	Cardinal	Club	Samsung	Dell
C	M	C	C	C
1024 x 768	640 x 480	1024 x 768	1024 x 768	640 x 480
6	2	8	5	3
None	None	None	None	None
2	2	2	2	2
1	1	1	1	1
Super VGA/1024 x 768	VGA/640 x 480	Super VGA/1024 x 768	Super VGA/1024 x 768	VGA/1024 x 768
1 MB	256 KB	1 MB	512 KB	256 KB
Diamond	Cardinal	Diamond	CompuAdd	Dell
●	○	●	○	Optional
S	MP	S	S	S
○	○	○	Optional	○
250	135	200	200	85
●	○	●	●	Optional
●	○	●	●	Optional
None	DR DOS 6.0	None	Diagnostics/Utilities	Diagnostics/Utilities
30-day money-back; 1 year parts and labor	1 year parts and labor	1 year parts and labor; on-site service	1 year parts and labor	1 year parts and labor; on-site service
$1595	$1299	$1665	$1095	$1199
$1595	$1419	$2394	$1988	$1708
None	387SX math coprocessor	240-MB hard drive, 387SX math coprocessor	120-MB hard drive, 2 MB of RAM, mouse, 387SX math coprocessor	120-MB hard drive, 2 MB of RAM

25-MHZ 386SX DESKTOP COMPUTERS

(● = yes; ○ = no; N/A = not available.)

Company	Duracom Computer Systems	Gateway 2000	JCC Systems	NEC Technologies	PC Brand
Model	Desksaver 386/25SX	25MHz 386SX	386SX-25	PowerMate S /25i	386/SX-25
Chips					
Brand of CPU	Intel, AMD	Intel	AMD	Intel	Intel
CPU upgrade	○	○	○	○	●
Brand of math coprocessor	Intel, Cyrix	Intel	IIT	Intel	Intel
Brand of motherboard chip set	DCL	Western Digital	VLSI	Western Digital	Western Digital
Brand of BIOS	AMI	Quadtel	AMI	NEC	PC Brand
Memory					
Standard RAM (DRAM)	1 MB	4 MB	1 MB	2 MB	4 MB
Max. RAM (DRAM)	16 MB	16 MB	32 MB	26 MB	16 MB
No. of wait states	None	None	None	None	None
Standard cache (SRAM)	N/A	N/A	N/A	16 KB	N/A
Max. cache (SRAM)	N/A	N/A	N/A	16 KB	N/A
Storage media					
Standard floppy configuration					
5 1/4-inch floppy drive	●	●	●	Optional	●
3 1/2-inch floppy drive	Optional	●	●	●	●
Standard hard disk configuration					
Brand and model	Maxtor 7080A/S	WD CA280	Seagate ST-3120	Quantum LPS105S	Conner CP-30104
Capacity	80 MB	80 MB	105 MB	105 MB	105 MB
Max. hard disk capacity offered	535 MB	500 MB	200 MB	240 MB	400 MB
Interface type	IDE	IDE (Optional SCSI)	IDE	IDE	IDE
Caching controller	○	●	●	○	○
No. of drive bays	6	3	3	4	2
Monitor					
Brand	Duracom	Gateway	Samtron	NEC	Supercom
Color (C)/Monochrome (M)	C	C	C	C	C
Max. resolution	1024 x 768	1024 x 768	1024 x 768	1024 x 768	1024 x 768
Expansion slots					
No. of ISA slots	8	5	6	4	7
Proprietary slots	None	None	None	None	CPU upgrade cartridge
Standard interfaces					
No. of serial ports	2	2	2	1	2
No. of parallel/printer ports	1	1	1	1	1
Video adapter/Resolution	Super VGA/1024 x 768	Super VGA/1024 x 768	Super VGA/1024 x 768	Super VGA/1280 x 1024	Super VGA/1024 x 768
Standard VRAM	1 MB	512 KB	1 MB	512 KB	512 KB
Brand of video adapter	Western Digital	Paradise	JCC	Tseng Labs	Orchid
Mouse included	Optional	●	●	●	●
Serial mouse (S)/Mouse port (MP)	S	S	S	S	S
Game port	●	○	●	○	○
Power Supply (watts)	200	200	200	250	130
Bundled Software					
MS-DOS 5.0	●	●	●	●	●
Windows 3.1	●	●	●	●	●
Other	○	Choice of Microsoft package	○	Utilities	○
Warranty	1 year parts and labor; on-site service	30-day money-back 1 year parts and labor	1 year parts and labor; on-site service	1 year parts and labor; on-site service	30-day money-back 1 year parts and labor; on-site service
List Prices					
Standard configuration	$1495	$1595	$1259	$1699	$1595
Review unit price	$1907	$1755	$1604	$3356	$1715
Review unit options	130-MB hard drive, Cyrix math coprocessor	387SX math coprocessor	2 MB of RAM, 387SX math coprocessor	4FG monitor, 2 MB of RAM, 387SX math coprocessor	387SX math coprocessor

PolyWell Computers	Tandy	Tangent Computer	Wyse Technology
Poly 386-25SX	2500 SX/25 HD	325s	Decision 386SX/25C
AMD	AMD	Intel	Intel, AMD
○	○	○	○
Cyrix	Intel	Cyrix	Cyrix
OPTI	AMD	OPTI	OPTI
AMI	Phoenix	AMI	AMI
2 MB	2 MB	4 MB	2 MB
16 MB	16 MB	16 MB	16 MB
None	None	None	None
16 KB	N/A	N/A	64 KB
64 KB	N/A	N/A	64 KB
●	Optional	Optional	Optional
Optional	●	●	●
Maxtor 7080	Quantum LPS120AT	Seagate ST-3120A	WD CA2120
80 MB	85 MB	100 MB	80 MB
535 MB	510 MB	510 MB	1.2 GB
IDE	IDE	IDE	IDE
Optional	N/A	○	●
5	1	5	5
Viewsonic	Tandy	Relisys	Wyse
C	C	C	C
640 x 480	1024 x 768	1024 x 768	1024 x 768
8	3	8	6
None	None	None	None
2	1	2	2
1	1	1	1
VGA/640 x 480	Super VGA/1024 x 768	Super VGA/1024 x 768	Super VGA/1024 x 768
256 KB	256 KB	512 KB	512 KB
Orchid	Western Digital	Diamond	Tseng ET4000
●	●	○	●
S	MP	S	MP
●	○	●	○
230	70	200	145
●	●	●	●
●	●	○	●
○	Microsoft Works for Windows	○	Utilities
1 year parts and labor; on-site service	1 year parts and labor; in-store service	1 year parts and labor	1 year parts and labor
$1200	$1299	$1595	$1599
$1650	$2823	$1715	$1719
2 MB of RAM, 120-MB hard drive, Cyrix math coprocessor	512 KB VRAM, 120-MB hard drive, 4 MB of RAM, 387SX math coprocessor, VGA monitor	Cyrix math coprocessor	Cyrix math coprocessor

AcerPower with its 486 upgrade in place turned in results that were between two and seven times those of the other machines we tested.

The CPU upgrade lets you triple or quadruple the performance of the Acer when running CPU-intensive applications. This performance increase lists for a nominal $175.

A Controller of Note

Another noteworthy feature also turned up in the AcerPower: a hefty UltraStor controller, the kind of device you'd expect to find in a beefy network server. Capable of handling up to two IDE hard drives and three floppy disk drives (3½- or 5¼-inch models) and carrying up to 8 MB worth of disk cache, the Ultra 15C comes with utility software that leads you through a slew of configuration options. For example, if you turn on the controller's deferred writing capabilities, you also can set a cache threshold that triggers a physical write. Writing occurs when the cache is filled to this threshold. Though we tested the AcerPower with only DOS and Windows applications, UltraStor claims compatibility with SCO Unix, NetWare, and OS/2. This surprise package will even support controller duplexing and drive mirroring.

The Ultra 15C supplied with our AcerPower included a 2-MB cache. We disabled its deferred writing (which, if on, would certainly have significantly improved the AcerPower's file I/O and database results) and set its cache threshold to 84 percent. As our analysis of benchmark results shows, even with these restrictions the Ultra 15C provided the AcerPower with disk I/O figures anyone would be proud of.

The BYTE Benchmarks

But disk I/O is just one of the benchmarks in the standard BYTE test suites we used to compare the performance of this group of 386SX machines. As usual, we ran each system through low- and medium-level tests that let us focus on the particulars of hardware performance and used application tests to provide a good snapshot of how these machines would behave when running real software (see the figure on page 232).

The applications tests cover two classes of software: DOS- and Windows-based packages. Since we were looking at 386SX machines and it was unlikely that anyone would choose to use a 386SX as a Unix workstation, we did not run BYTE's Unix test suite.

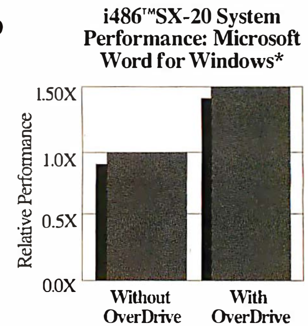
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Though our benchmarks are not specifically designed to measure compatibility, we often discover problems while simply loading and executing such a variety of applications—especially Windows programs. Happily, none of the systems we tested exhibited major problems.

Running so many systems through so many benchmarks creates a mind-numbing buzz of numbers. We distilled those numbers by grouping tests into five categories—word processing, spreadsheets, database, development, and scientific/CAD—and computing indexes for each category. The resulting collection of five indexes helped us to narrow our search for the top machines.

After examining the data, we were struck by how tightly the results were clustered. This was true for both our DOS and Windows tests. Indeed, if you consider performance alone, you find neither outstanding winners nor outstanding losers on the tests.

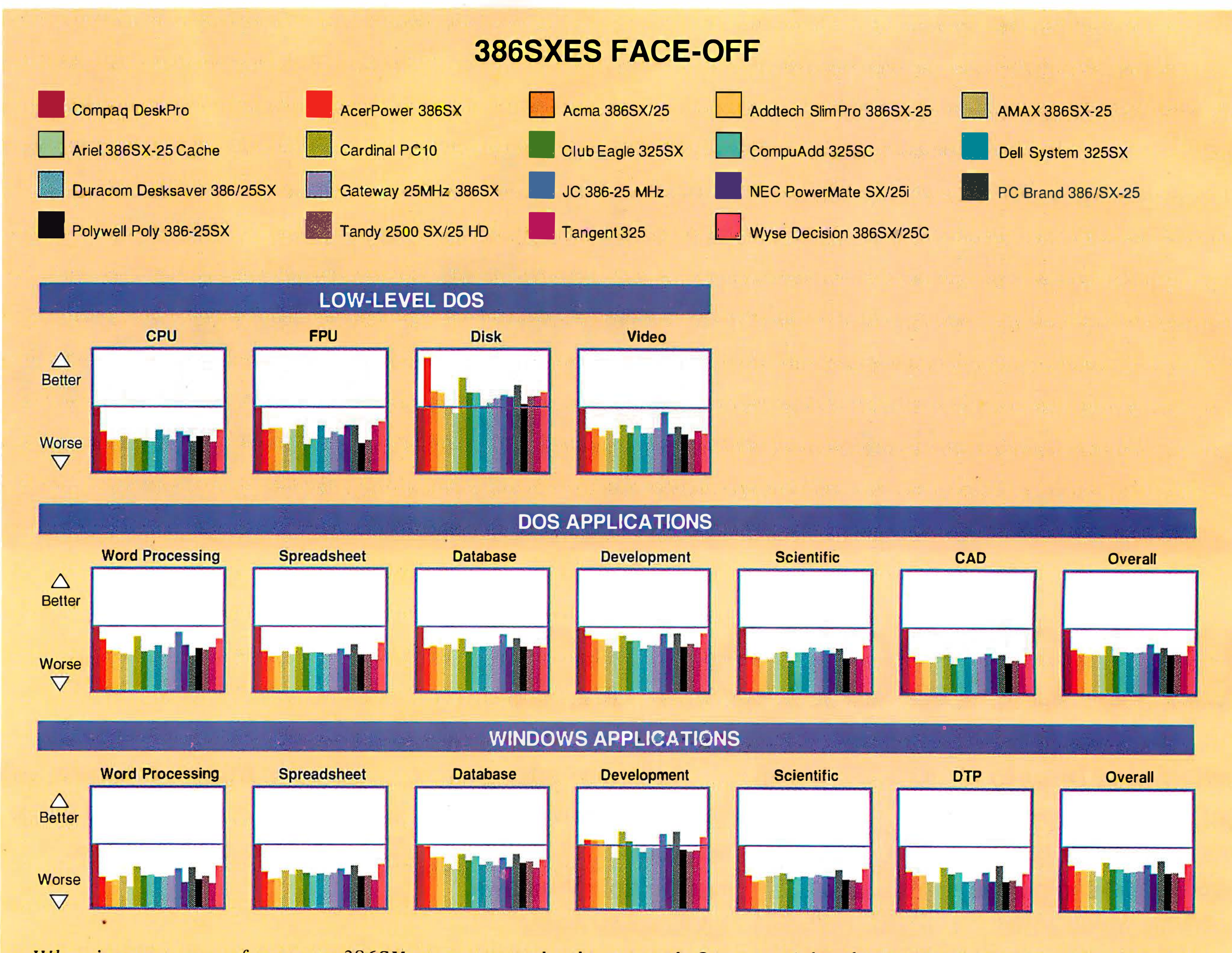
Of course, occasional anomalies cropped up, but their significance became obvious when we explored the benchmark results on a single large spreadsheet. For example, the AcerPower turned in unusually good figures for low-level I/O and Windows database tests. The Acer's fine showing can be traced to its Ultra 15C caching drive controller from UltraStor.

Ultimately, we managed to select two performance winners: the Wyse Decision 386SX/25C and the PolyWell Poly 386-25SX. Keep in mind, however, that our benchmark results reveal a close race. For example, the NEC PowerMate SX/25i showed up twice in the winner's circle—once for word processing and again for database performance. Also, our performance indexes reflect overall results; the anomalies mentioned earlier—outstanding performance on one or two tests—were smoothed out during the indexing process.

Buying Decisions

As we evaluated these systems, a question hung in the air: How wise an investment is a 386SX system really? None of these systems is *bad,* but all the advantages we can find seem so *marginal.* What are the advantages? Price...maybe. Space? Let's consider these issues.

continued



When it comes to performance, 386SX systems are closely grouped. Our two picks, the PolyWell Poly 386-25SX and the Wyse Decision 386SX/25C, placed well across the board. The NEC PowerMate SX/25i also performed well.

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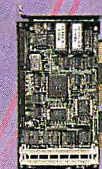
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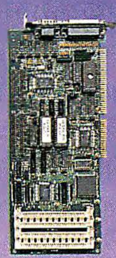
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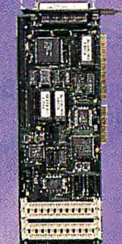
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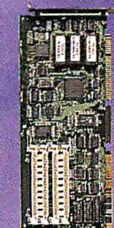
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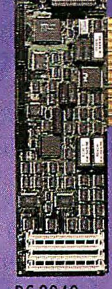

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Hard drive depicted is the Maxtor LXT535 IDE drive. Provided courtesy of Maxtor Corporation.

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With new 80x86 processors sprouting in Intel's fertile soil so frequently these days, it's difficult to tell what par is anymore, but 33-MHz 386DX machines are easily obtained at prices not far beyond what you'd pay for any of these 386SX machines. And it's obvious that a 33-MHz 386DX is going to run through tasks more quickly than a 25-MHz 386SX (our benchmarks indicate performance improvements of 200 percent to 500 percent when running a DX system).

Granted, you're not buying just a processor—you're buying a complete system, and that includes disk controllers and monitors and maybe tape drives and so on. A good caching disk controller loaded up with lots of memory can go a long way to making up for a sluggish processor. You can even get Windows accelerator cards to put zing in graphics operations.

But with price differences of only $200 to $300 in favor of the 386SX, the only economic reasons for going the SX route are if you're really strapped for funds and you don't have the time to shop around. A good shopper can easily make up a $300 difference. All those accelerator cards and caching controllers would be just as happy—*happier*, in fact—in a DX system.

Economics aside, someone might argue that the 386SX allows for space-conscious designs, and makes possible machines such as the Cardinal and the Addtech. But it's hard to imagine a space that could accommodate any kind of monitor worth spending time with but that can't fit a reasonably sized desktop computer. We've seen 486 systems as small as or smaller than many of the 386SX systems we tested in this product report.

If, knowing the breed's limitations, you still decide to buy a 386SX system, we recommend you seek out the PolyWell Poly 386-25SX or the Wyse Decision 386SX/25C system. But your rationale must be a good one—strong enough to warrant choosing the less capable 386SX over a 386DX. Frankly, we'd be hard put to think of a single such reason. ■

Rick Grehan is technical director of the BYTE Lab. He has a B.S. in physics and applied mathematics and an M.S. in mathematics/computer science. Stan Wszola is a BYTE Lab testing editor. You can reach them on BIX as "rick_g" and "stan," respectively.

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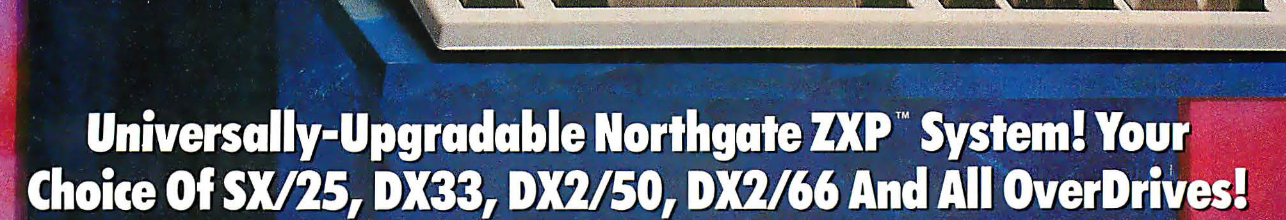
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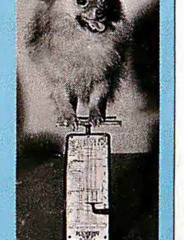
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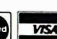
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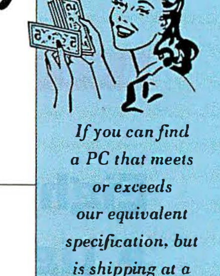
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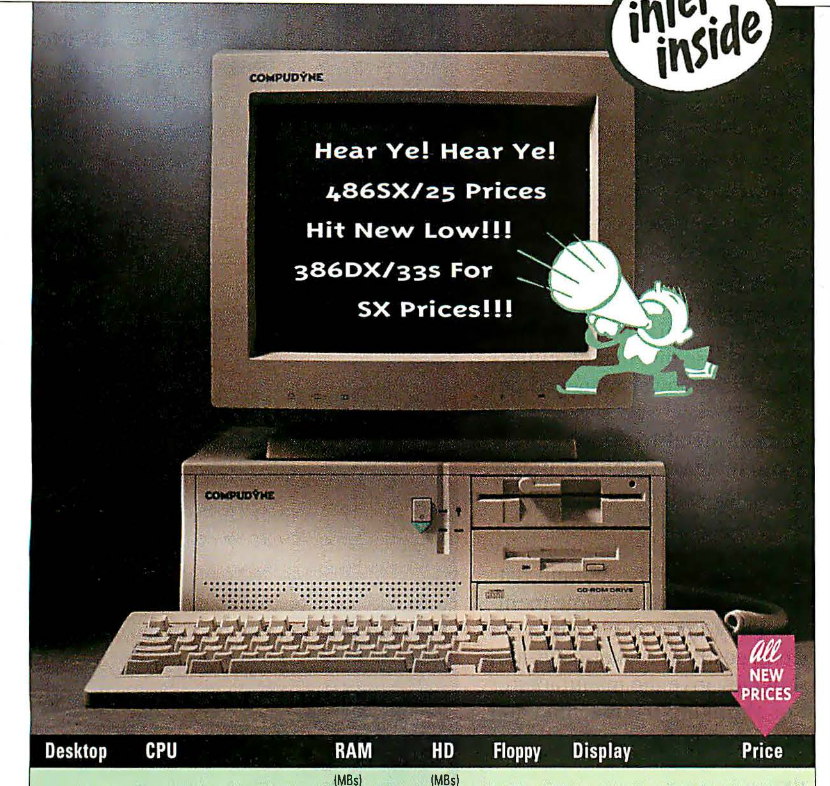
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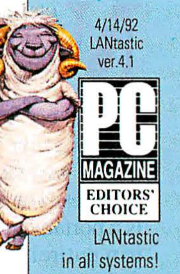
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486SX/25	Intel 80486SX-25 MHz Built-in 8K CPU cache	2 standard 32 max	80	1.2 & 1.44	16 bit SVGA card 14" 1024x768 SVGA Color Monitor	$1,299 $48/mo*
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486DX/33 CACHE	Intel 80486DX-33 MHz 128K CPU cache	4 standard 64 max	130	as above	as above	$1,799 $67/mo*
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JIM CARLS

Notebook computers run on batteries. Well, mostly. But the slightest chance that built-in batteries will not outlast a cross-country trip or carry you through an important presentation means you need to travel armed with an AC power cord and extra batteries. The Holy Grail of notebook users is a portable machine that will last a whole trip entirely on its own resources—one that lets you leave the accessories at home.

New processors and advances in power management have moved us closer to this ultimate goal. In this article, I'll review eight notebooks based on Intel's 386SL and AMD's 386SXL processors. These machines take advantage of the sophisticated power management features offered by these processors, along with other recent advances in portable technology, to extend battery life. BYTE's latest battery-life test suite (see the text box "A New Thumper" on page 250) will be the main proving ground. But I'll also evaluate the portability and the "feel" of Compaq's LTE Lite/25, Dell's NL25, Epson's NB-SL/25, Insight's 386SXL-25, NCR's 3170, NEC's UltraLite SL/20, Sharp's PC-6781, and Zenith Data Systems' Z-Note 325L.

Enabling Technology

Processors designed with power management in mind lead the list of new technologies driving improvements in battery life. Intel's 386SL provides System Management Mode, a software environment ideal for power management functions. The device also combines processor, cache controller, and bus controller into a single chip; a few other peripherals are included in Intel's companion 82369SL device. This high level of integration gives the system better control over its subsystems and reduces overall power requirements.

AMD offers its own 386-compatible, power management–aware processor called the 386SXL. This processor provides an interrupt line that manufacturers can incorporate into power-managed designs.

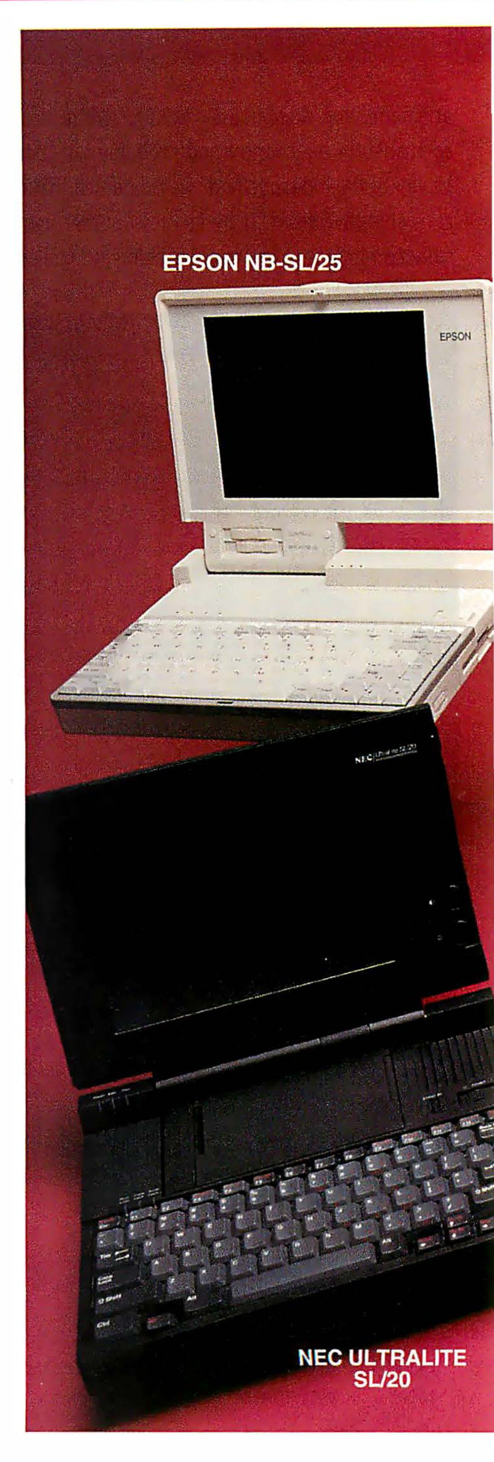
NiMH (nickel-metal-hydride) battery technology can increase notebook life by providing batteries with increased capacity per cubic inch. NiMH batteries provide 20 percent to 30 percent better capacity than more common nickel-cadmium batteries and are less subject to charge memory effects. They are more expensive (about twice as costly as nickel-cadmium batteries), but they give the manufacturer the option of shrinking the machine and maintaining duration of use.

Standard Features

The feature list for these computers shows a great deal of standardization in notebook design (see the table). While this trend may be driven by user wish lists, it also reflects these machines' greater level of integration. Each system includes a 60- to 86-MB hard drive, a backlit LCD, and a 1.44-MB internal floppy drive (the NCR 3170's floppy drive is external). All come with at least 2 MB of RAM; for this review BYTE requested a minimum of 4 MB. All accept an optional modem or fax modem card, except the NCR 3170, which already has one.

Each machine includes a power management system that allows you to regulate how and when the machine uses power, with at least one factory-set configuration. At a minimum, you can control processor speed, backlighting, and hard drive activity through time-outs. Each machine also has at least one standby or idle mode, in which the power manager stops the clock on the processor and shuts down all subsystems except memory. Each machine can resume operations if a signal comes in through the serial or modem port. All these machines have a configuration program to customize power management, but only four (the NL25, the NB-SL/25, the UltraLite SL/20, and the Z-Note 325L) offer access to system configuration from within an application.

In the following sections, I'll evaluate each machine for battery life and perfor-





Machines range in size from the bulky NEC UltraLite SL/20, which stands over 2 inches high, to the amazingly compact Sharp PC-6781, which crams a full system into less than 150 cubic inches.

BYTE ACTION SUMMARY

- **WHAT POWER-SAVING NOTEBOOKS ARE**
  Notebooks designed around Intel's 386SL and AMD's 386SXL to minimize power requirements and extend battery life.

- **LIKES**
  Long notebook life; integrated networking and communications; small and lightweight designs.

- **DISLIKES**
  Many poor keyboard layouts; some expensive price tags.

- **RECOMMENDATIONS**
  ZDS's Z-Note 325L is outstanding in most categories; Compaq's LTE Lite/25 and NCR's 3170 are more compact alternatives; and Dell's NL25 is comfortable and reasonably priced.

mance. You can find the benchmark graphs to back up these evaluations in the figure on page 249. I've also included subjective impressions on keyboard design and display usability, which often determine how pleasant (or uncomfortable) a notebook is to carry and use.

Compaq LTE Lite/25

The $2799 LTE Lite/25, boosted by strong video scores, ran close to the top in the BYTE application performance tests. It also performed very well on batteries, running second only to the Z-Note.

The LTE offers three preset levels of power management and one custom level. You cannot customize individual component controls from within a program, but you can step through the four predefined levels with a hot key. In addition to the zero-activity standby mode, the LTE offers an intermediate system-idle mode and a hibernation mode, in which the system saves a RAM image to disk and shuts off. You can activate a small pop-up battery gauge from the keyboard that remains visible as you work.

The LTE's keyboard is a good tradeoff between compactness and usability. All the most common keys are accessible without shifting, although the Home, End, PageUp, and PageDown keys are inconveniently located in the top row.

The screen on this machine is one of the best in the group, giving a very good range of contrast. The darkest "grays" look blue, which I found slightly distracting, but there was no arguing with the readability of the screen. It's a very solid piece of equipment.

Dell NL25

As one might expect from Dell, the $2178 NL25 is a very good value for its price. It's a well-balanced machine, with many good features and no bad ones. Its battery life was shorter than some, but still respectable; its performance marks were usually just behind the best in the group and occasionally surpassed them. Dell provides a pop-up configuration screen for power management, making it easy to adjust settings while you work.

The NL25 takes first place in keyboard quality. Not only does it have a very good touch, but all the keys are in the most

FEATURES OF POWER-SAVING NOTEBOOKS

Price, size, and weight of these notebooks cover a broad range. Insight's and Dell's systems are the least expensive, selling for less than half the price of the full-featured NCR 3170. Sharp's PC-6781 is the smallest machine.
(● = yes; ○ = no.)

	Compaq LTE Lite/25	Dell NL25	Epson NB-SL/25	Insight 386SXL-25	NCR 3170	NEC UltraLite SL/20	Sharp PC-6781	ZDS Z-Note 325L
Price[1] Base unit	$2799	$1999	$3099	$1899	$5399[2]	$2999	$2599	$4299
As tested	$2799	$2178	$3298[3]	$1899	$5748[2]	$3268	$2898	$4299
Processor	i386SL-25	i386SL-25	i386SL-25	Am386SXL-25	i386SL-25	i386SL-20	i386SL-20	i386SL-25
Clock speeds (MHz)	25/6.2	25/8	25/6.25	25/6	25/3.25	20/5	20/5	25/6.25
RAM (base/maximum; MB)	4/10	2/8	4/20	4/8	2/20	2/8	2/8	4/12
Hard drive capacity (MB)	84	60	60	86	80	80	80	85
PCMCIA 2.0 slot	○	○	○	○	●	○	●	○
Display type[4]	Edgelit STN	Edgelit TSTN	Backlit STN	Edgelit TSTN	Backlit TSTN	Backlit STN	Backlit TSTN	Edgelit TSTN
Pointing device	None	None	None	Mouse	FingerPoint Mouse	None	Internal trackball	Clip-on trackball
Ports[5]	M/K, N, E, D	M/K/N	M/K/N, P/D	M/K/N	M/K/N, E, D	M, K, N, E, D	N, E, B, P/D	M/N, E
Dimensions (D × W × H; inches)	8.5 × 11 × 1.75	8.5 × 11 × 1.8	9.25 × 11.7 × 2	8.5 × 11 × 1.8	8.5 × 11 × 1.8	9 × 11 × 2.2	8.5 × 11 × 1.6	8.5 × 11.9 × 1.9
Weight (lbs.)	6.0	6.3	7.2	5.8	4.9	6.4	4.9	5.9
Battery technology	NiMH	Nickel cadmium	Nickel cadmium	Nickel cadmium	Nickel cadmium	Nickel cadmium	Nickel cadmium	NiMH

1 Unless otherwise noted, as-tested price includes 4 MB of RAM, no modem, and features as listed in this table; base configurations vary.
2 NCR 3170 configuration includes fax modem.
3 NB-SL/25 configuration included 6 MB of RAM.
4 All units include a VGA-compatible LCD and an external VGA port. STN = supertwist nematic; TSTN = triple-supertwist nematic.
5 In addition to the ports listed, each unit includes one parallel and one serial port. M = mouse; K = keyboard; N = numeric keypad; E = expansion unit; D = external floppy drive; P = extra parallel port; B = external battery. Entries separated by a slash indicate a multipurpose port.

usable arrangement possible on a compact keyboard. The Insert, Delete, and all cursor-movement keys are placed individually around the lower right corner where they are easy to access. The function keys at the top of the keyboard are not quite full-size, but they're still big enough to use effectively.

Although the screen is not quite as bright as the best of the others, it has good cursor visibility. The NL25 is well designed, and I can recommend it for those who plan to write and edit a lot of text.

Epson NB-SL/25

For its $3298 list price, the NB-SL/25 gives you several good features, balanced by some unfortunate ones. For travelers, Epson provides a renewable "road service" guarantee, which will quickly replace all or part of a downed system at no charge. In computing speed, the NB-SL/25 held its own against the other top performers.

The NB-SL/25 comes with two batteries, between which the unit will switch automatically. You can change the battery not being used while the system is running. Despite the dual batteries, lifetime was below average.

This unit has a well-thought-out keyboard that minimizes the finger-twisting sometimes needed to access cursor-control keys on other units, but the murky screen lagged behind those of the rest of this group.

Insight 386SXL-25

Insight's machine lists at $1899 (including an 86-MB hard drive and a mouse), making it a very good deal despite performance that didn't quite keep pace. This is the only machine in the group that uses AMD's 386SXL chip; the 386SXL-25 held up very well on BYTE's battery-life tests. A command-line utility controls power management, offering fairly basic control over management settings.

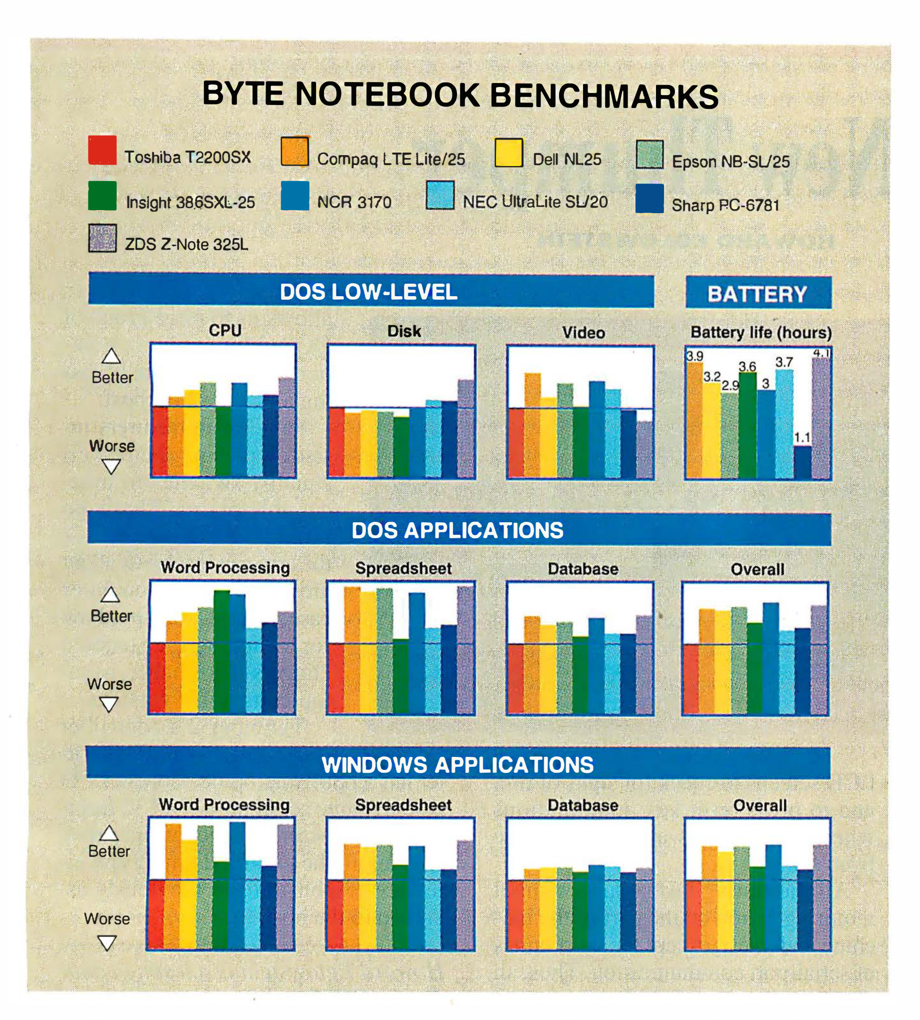
The keyboard has a slightly soft feel to it that some might not enjoy, but it reduced fatigue when I was typing flat-out. The 386SXL-25 has a good screen—almost as good as the Z-Note's.

NCR 3170

The 3170 (which until recently was called the Safari SSL/25) is the second-smallest and most expensive machine in the test group. The $5748 notebook is also the only machine with a built-in fax modem and an outboard drive, and one of only two with a PCMCIA slot. The LCD screen is extremely readable, and the 3170's designers have paid special attention to mouse pointer visibility. The keyboard is good, albeit a bit stiff, and it suffers from the location of the Home, End, PageUp, and PageDown keys at the top.

The 3170 offers a configuration screen that includes power management settings. Besides the standard set of time-outs, you can disable power for unused ports or slots, and you can lock the CPU speed for processing-intensive software. At just over 3 hours on BYTE's tests, battery life was reasonable, but the 3170 trailed most of the other systems.

For basic cursor and mouse control, the 3170 offers the FingerPoint Mouse, which consists of what might be called a "joy-



All results are indexed, and higher numbers indicate better performance. For each index in the DOS and Windows tests, a Toshiba T2200SX running DOS 5.0 and Windows 3.0 = 1.

The BYTE low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component. The results of these tests can help you identify the relative performance of a given subsystem and determine where performance bottlenecks may lie. For a complete description of these tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990 BYTE. The BYTE low-level benchmarks, version 2.2, are available in the byte.bmarks conference on BIX, or you can contact BYTE directly.

BYTE's application performance suite measures the performance you can expect to see running a given application category under a given operating environment. We test under two environments: DOS 5.0 and Windows 3.0. We test three application categories for each environment, running test scripts using the following programs: Word Processing: WordPerfect 5.1 and Lotus Ami Pro 2.0; Spreadsheet: Lotus 1-2-3 release 2.3 and Microsoft Excel 3.0a; and Database: Software Publishing Superbase 4 version 1.3 and Borland dBase IV. The data files and test scripts are available from BYTE.

Battery-life tests illustrate the Z-Note 325L's and the LTE Lite/25's edge in power conservation; the two machines ran longest through BYTE's "typical use" suite. Although easily portable, the Sharp PC-6781 turned in a poor running time. The LTE and the Z-Note, along with the NCR 3170, are also the fastest notebooks in this class.

button" flanked by two other buttons used as left and right mouse buttons. With its dual speeds, the FingerPoint Mouse is a fairly effective pointing device, but NCR wisely notes that it is not meant to replace a real mouse or trackball.

The real value of the 3170 lies in its plug-and-play approach. It comes out of the carton loaded with Windows, AT&T Mail Access Plus, and BitFax 2.0, which works with the included cellular-ready 2400-/9600-bps fax modem. I typed a very quick message into Windows Write and was immediately able to fax it to a friend just by plugging in the phone line and selecting the fax as the current printer.

NEC UltraLite SL/20

This machine is one of the two 20-MHz machines included in this group. At $3268, it falls in the middle of the price range. The UltraLite proved an excellent battery performer—third in this group.

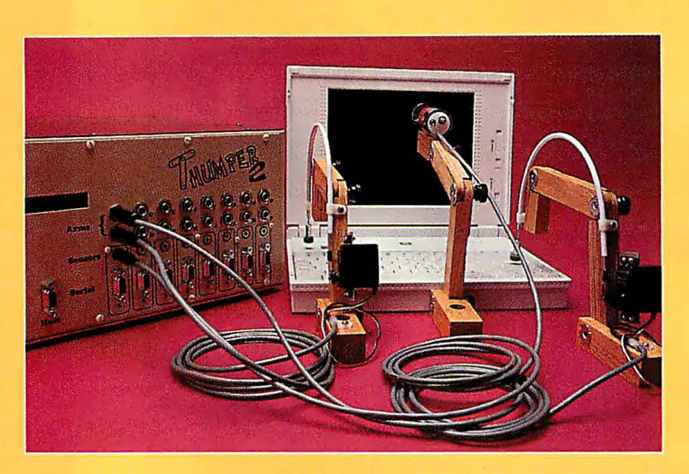
The UltraLite's CPU goes into an idle mode as soon as system activity stops. You configure power management features through a pop-up utility.

The UltraLite has a crisp screen framed

A New Thumper

HOWARD EGLOWSTEIN

Last December, the BYTE Lab introduced Thumper 2, our automated notebook battery tester (see "Testing Battery Life," December 1991 BYTE, page 252). The photo in the December issue was of the prototype—the real one was still on the drawing board. The new Thumper 2 makes testing a large group of notebooks much easier. It uses the same arm mechanism as the prototype, but it has 16 arms instead of three, and eight optical sensor heads instead of one. Depending on how many actuator arms a notebook needs, we can now test up to eight notebooks at a time.



Our battery-life tests approximate real-life notebook use by alternately using (i.e., typing on the keyboard) and not using (i.e., allowing power-saving features to kick in) each machine under test. We use Thumper 2 to press keys during the usage periods, to monitor LCD screens to check for signs of life, and to press reset key combinations when we need to wake the machine from standby mode.

All the testing takes place without requiring action on the part of the machine under test, except for short bursts of serial-port communication. Thus, all the battery-saving features, including screen dimming, hard drive shutdown, and CPU standby, have a chance to contribute to extended life. Thumper 2 allows us to run a group of DOS, Mac, or Unix notebooks simultaneously, using a PC or a Mac host.

Some manufacturers insist on placing the power/standby switches in inaccessible places. That's no problem for Thumper 2—the arm can reach just about any spot on the computer case. Removable tips allow for swapping the standard "fingers" for smaller, palmtop-compatible versions.

Thumper 2's controller is updated as well. This critter has a 6809 microprocessor, an LCD display, nine serial ports, and 32 front-panel connectors. The controller now handles all the low-level timing and interface responsibilities previously assigned to the host.

Howard Eglowstein is a testing editor for the BYTE Lab and the designer of the Thumper 2 battery-life tester. You can reach him on BIX as "heglowstein."

by a jet-black case. Although not quite as good as the screen of the Z-Note or LTE, it was quite readable in artificial light. In direct sunlight, it presented almost-black characters against a light-green background and was one of the more readable.

Sharp PC-6781

The PC-6781 packs an amazing number of features, including a built-in trackball and a PCMCIA slot, into a tiny, 4.9-pound rubberized case. At $2898, it easily matches the features of the other machines in its price range. However, it lags in both battery life and performance.

Although you can pop up the configuration screen while using another program, the machine resets when you exit. Like the LTE, this machine offers a "suspend-to-disk" shutdown mode.

The PC-6781's keyboard is adequate, although it is so flat that in some lighting conditions it looked painted onto the machine. It suffers from key-travel limitations. The trackball is, well, cute. It is a variable-response device, which moves the pointer farther the faster you turn the ball. This sounds like a good idea, but in practice it usually means you must spend several moments hunting down the pointer. The trackball is located on the right side, above the keyboard, with the buttons on the left, requiring two-handed use.

ZDS Z-Note 325L

Housed in a clean-looking white case, this computer leaps over most of the others in this group with its excellent display, performance, and ease of use. The $4299 Z-Note 325L comes with a built-in NE2000-compatible network adapter and several standard network shells; all you have to do is buy the appropriate cable adapter from ZDS. One great innovation is the optional Port Replicator, which lets you permanently attach your home or office cables to an adapter that snaps onto the rear of the Z-Note.

The Z-Note uses NiMH batteries. It proved untouchable on BYTE's battery-life tests, besting the second-place LTE by over a half hour. A pop-up configuration utility includes a screen of standard power management settings for both AC and battery operation.

The keys are full size, although a bit flat, with all the standard cursor-movement keys easily accessible at the right side of the keyboard. Unfortunately, the full-size keys make the Z-Note wider than most notebooks; this is the only unit that wouldn't fit vertically in my briefcase.

The screen is simply the best in this group, if not the best among all laptops I've seen. It was bright, with extremely good contrast, and Windows displays were flawless. Where most machines have simple normal or reverse controls on the LCD, ZDS provides a multistep adjustment that

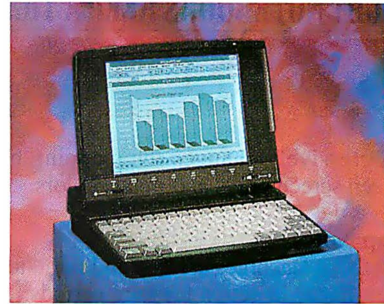
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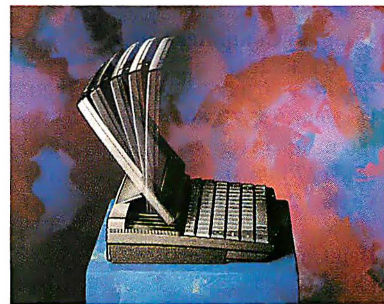
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progressively changes the mapping between screen grays and image colors.

Top Notes

All these machines are fast and light, and they'll stay in action for long periods.

If you have the cash, the ZDS Z-Note 325L and the Compaq LTE Lite/25 stand out as excellent all-around machines. If you have even more cash, try to work a deal on the NCR 3170. And finally, if you want a reasonably priced, comfortable machine that lacks only some bells and whistles, give the Dell NL25 a try. ■

Jim Carls is a computer consultant and freelance writer from Memphis, Tennessee. You can reach him on BIX c/o "editors."

COMPANY INFORMATION

Compaq Computer Corp.
(LTE Lite/25)
P.O. Box 692000
Houston, TX 77269
(800) 345-1518
(713) 370-0670
Circle 1223 on Inquiry Card.

Dell Computer Corp.
(NL25)
9505 Arboretum Blvd.
Austin, TX 78759
(800) 289-3355
(512) 338-4400
fax: (512) 338-8700
Circle 1224 on Inquiry Card.

Epson America, Inc.
(NB-SL/25)
20770 Madrona Ave.
Torrance, CA 90503
(800) 922-8911
(310) 782-0770
fax: (310) 782-5220
Circle 1225 on Inquiry Card.

Insight Computers
(386SXL-25)
1912 West Fourth St.
Tempe, AZ 85281
(800) 755-9628
(602) 350-1176
fax: (602) 350-1182
Circle 1226 on Inquiry Card.

NCR Corp.
(3170)
Notebook Computing
Business Unit
P.O. Box 6497
Somerset, NJ 08873
(908) 302-5800
fax: (908) 469-4578
Circle 1227 on Inquiry Card.

NEC Technologies, Inc.
(UltraLite SL/20)
1414 Massachusetts Ave.
Boxborough, MA 01719
(800) 388-8888
(508) 264-8000
fax: (508) 264-8764
Circle 1228 on Inquiry Card.

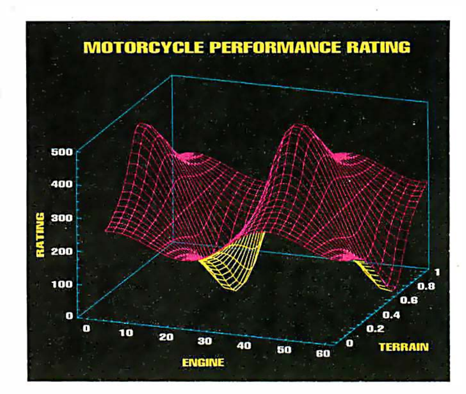
Sharp Electronics Corp.
(PC-6781)
Sharp Plaza
Mahwah, NJ 07430
(800) 237-4277
(201) 529-9600
Circle 1229 on Inquiry Card.

Zenith Data Systems
(Z-Note 325L)
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Buffalo Grove, IL 60089
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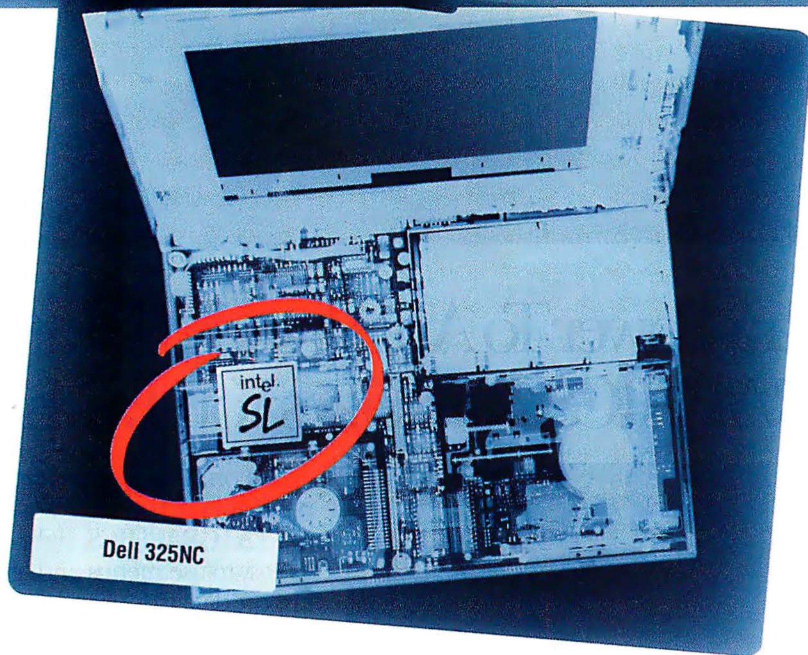
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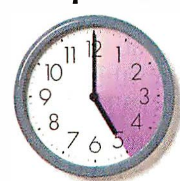
Look what's at the heart

Take a closer look at some of the best notebook computers and it's easy to see why the prognosis is so good—they each have an Intel SL microprocessor.

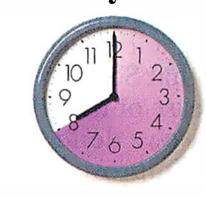
The Intel SL gives each of these unique notebooks a leg up, because it was designed specifically for the stop-and-go world of mobile computing.

For example, the Intel SL has an instant on/off feature that eliminates long boot-up and shut-down sequences. If you're interrupted, the Intel SL holds your place and puts your entire system into suspended animation, using virtually no

Stop-and-Go Battery Life*







Intel SL
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NCR 3170

Zenith Data Systems
Z-NOTE 325Lc

Compaq LTE Lite/25

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The Intel SL is a more highly-integrated microprocessor, which means lighter, more feature-rich notebooks that come in speeds up to 25 MHz. No wonder major manufacturers are prescribing the Intel386™SL microprocessor as a cure for traveling hassles.

Call 1-800-228-4549 to receive more information and a complete list of Intel SL-based notebooks.

Then watch for notebooks with the Intel SL. Because nothing else is worth looking into.



SYSTEM

486 Notebooks Double as Desktops

BARRY NANCE

With enough horsepower and sufficient connectivity options, a notebook computer doesn't have to be a second PC that you use just for traveling. A powerful notebook can be a desktop computer as well as a traveling companion, saving the expense of two machines and keeping your projects easily accessible.

I have some strict requirements that a notebook has to fulfill before it can double as my desktop machine. This month, I look at four 486-based notebooks that go a long way toward delivering on the notebook/desktop promise: Compudyne's 4DX/33, Ergo's NoteBrick 486, Gateway 2000's Nomad 420SXL, and Toshiba's T4400SX. I evaluated the machines at odd times and places, indoors and out, in the office and on the road. By the time I finished the review, I had bought one of these notebook PCs (I'll tell you which one, and why, at the end of this article).

All four computers can run OS/2 2.0, DOS, Windows 3.1, and SCO Open Desktop. I used a variety of applications as well: Microsoft's Word for Windows, Excel, and Visual Basic; Borland's Paradox for Windows, ObjectVision, and Borland C++; Watcom's C/386 9.0 compiler; Lotus's Ami Pro and 1-2-3 for OS/2; and Qualitas's 386Max. My son also loaded some games on the notebooks. All of this software ran without incident.



Although slightly bulkier than typical 386SX or 386SL designs, 486 notebooks handle tasks that slower processors can't easily accomplish. Clockwise from left: Gateway 2000's Nomad 420SXL, Toshiba's T4400SX, Ergo's NoteBrick 486, and Compudyne's 4DX/33.

Where to Look, What to Look For

These four notebooks have something to say about the sources of new portable technology. One was made in Texas, one in Japan, and the two fastest in Taiwan; only one (the Toshiba T4400SX) is manufactured and sold by the same company. Gateway's system is based on a Texas Instruments design, Ergo's NoteBrick 486 is built by Nantan, and the Compudyne 4DX/33 is manufactured by Twinhead.

The figure shows benchmark results for performance and battery life. [Editor's note: *For a description of the BYTE battery-life tests, see the text box "A New Thumper" on page 250.*] When you evaluate high-end notebooks, in contrast to 386SX and 386SL systems, I believe that battery life has to take a back seat to performance. At your desk, you'll use an AC charger. Traveling, you'll be ready for a break after 2 or 3 hours. If you buy an additional battery pack, you can slip it into the computer after your break and keep on running.

Each of these computers lasts at least 2 hours on one charged battery. Gateway says the Nomad will last 6 to 7 hours if all its power management features are enabled, but BYTE's battery-life tests rate realistic running time at closer to 4½ hours. The T4400SX had the longest running time on a single battery (at 4 hours, 39 minutes), while the NoteBrick 486 (at 1 hour, 40 minutes) ran the shortest time. In any case, I highly recommend getting an extra battery for any of these computers.

In addition to their speed, compatibility, and sizable hard drives, these notebook computers share one other trait—durability. Notebook PCs are getting more and more rugged. Even the plastic covers over the serial and parallel ports were more difficult to dislodge than they would have been on notebooks made just a year ago. All four computers survived being carried under my arm, being tossed on the seat of my car, and being used by my 16-year-old son.

continued

BYTE ACTION SUMMARY

WHAT 486 NOTEBOOKS DO
They put the computing power of a 486SX or a 486DX into a small, portable package.

LIKES
You can realistically expect to complete development projects or other compute-intensive tasks on the road.

DISLIKES
Keyboard layouts are clumsy, for the most part. The larger systems are also somewhat bulky.

RECOMMENDATIONS
For the quietest, slimmest notebook, get the Compudyne 4DX/33. The Ergo NoteBrick 486 has the best keyboard.

FEATURES OF 486 NOTEBOOKS

Gateway's Nomad 420SXL, based on a 486SX processor, is far and away the price leader. The Compudyne 4DX/33 and Ergo NoteBrick 486 compete for the high end, but the Compudyne system is considerably smaller and lighter.

	Compudyne 4DX/33	Ergo NoteBrick 486	Gateway 2000 Nomad 420SXL	Toshiba T4400SX
Price[1]	$2999	$2995	$2795	$4349
System unit				
Processor	33-MHz 486DX	33-MHz 486DX	20-MHz 486SX	25-MHz 486SX
RAM (base/ maximum; MB)	4/20	4/16	4/20	2/10
Hard drive capacity (MB)	127	170	80	80
Internal floppy drive (MB)	1.44	1.44	1.44	1.44
Dimensions (D × W × H; inches)	8.7 × 11 × 1.6	10.2 × 11.2 × 2.2	8.5 × 11 × 1.8	8.3 × 11.2 × 2.2
Weight (lbs.)	6.25	8.7	5.8	7.25
Keyboard				
Number of keys	84	82	79	82
External connector	Yes	Yes	No	Optional
Key travel (mm)	2.0	3.0	2.0	2.5
PageUp/PageDown	Yes	Yes	No	Yes
Insert/Delete in lower right	No	Yes	No	Yes
Display				
LCD type[2]	Backlit STN	Backlit STN	Backlit STN	Backlit STN[3]
Resolution	640 × 480	640 × 480	40 × 480	640 × 480
Gray scales	64	32	64	16
Viewing area (H × W; inches)	5.8 × 7.6	5.2 × 6.8	6 × 7.9	7 × 7.7
Super VGA external	Yes	Yes	Yes	Yes
Battery				
Technology	Nickel-cadmium	Nickel-cadmium	Nickel-cadmium	Nickel-cadmium
Recharge time (hrs.)	2	2	2.5	1.5
External power supply/charger				
Dimensions (D × W × H; inches)	6 x 1.5 × 3	6.25 × 2 × 3	6.25 × 1.7 × 2.25	6.25 × 1.7 × 3
Weight (lbs.)	1.5	1.5	1	2
General				
Serial ports	One	Two	One	One
Parallel ports	One	One	One	One
Pointing device	Internal trackball	External mouse	External trackball	None
Internal modem support	Yes	Yes	No	Yes
Expansion chassis port	Yes	Yes	Yes	Yes
Bundled software	DOS 5.0, Windows 3.1, PackRat (PIM)	DOS 5.0, Windows 3.1, AddStor	DOS 5.0, Windows 3.1	DOS 5.0

[1] Unless otherwise noted, price includes 4 MB of RAM, no modem, and features as listed in this table.
[2] All units include VGA-compatible LCD and external VGA port. STN = supertwist nematic; TSTN = triple-supertwist nematic.
[3] Color LCD, gas plasma optional.

These notebook powerhouses aren't without their drawbacks, though. When you're on the road (and even in the office, unless you attach an external keyboard), you're faced with a small keyboard. The keys don't have quite the travel of those on a full-size keyboard, and you'll have to get used to the different layout.

The features table details configurations. In the following sections, I'll give my account of what it's like to use these systems.

Compudyne 4DX/33

Compudyne's 4DX/33 notebook is manufactured by Taiwan-based Twinhead. Compudyne itself is the mail-order division of the CompUSA chain of computer stores. The 4DX/33 is the slimmest and quietest of the four notebooks in this review and quite inexpensive at $2999. It's fast (33 MHz), the standard hard drive is 127 MB, and it comes with a built-in trackball.

The 4DX/33's keyboard doesn't have quite the feel of the T4400SX's or the NoteBrick 486's, but it's more than adequate. The PageUp, PageDown, Home, and End keys are dedicated, and the Control, Caps Lock, and tilde keys are in the same positions as they are on a full-size 101-key keyboard. The Insert and Delete keys are badly placed in the upper right corner of the keyboard.

The built-in trackball is especially handy when you're trying to work while sitting in the cramped coach section of a crowded airline flight. The Cirrus Logic LCD screen features 64 gray scales, quick response, and a clear, brilliant display. The brightness/contrast controls are recessed and stay where you put them.

In addition to DOS 5.0 and Windows 3.1, Compudyne gives you a copy of PackRat, a PIM (personal information manager) from Polaris.

Ergo NoteBrick 486

Nantan manufactures the NoteBrick 486 computer for Ergo Computing. The $2995 NoteBrick 486 is larger, heavier, and noisier than the other notebooks. It is, frankly, a brute. But it is very reasonably priced, comes standard with a carrying case and numeric keypad, and has the nicest keyboard of all four notebooks. The NoteBrick 486 runs at 33 MHz, has a standard 170-MB hard drive, and ships with 4 MB of RAM. The unit Ergo sent for review was a top-end configuration with a full 16 MB of RAM that sells for $3895.

Nantan has manufactured keyboards for years; the company's expertise shows in the NoteBrick 486's. There are dedicated PageUp, PageDown, Home, and End keys. The Insert and Delete keys are in their proper positions in the lower right corner. And the feel of the keyboard is superior, almost as good as that of a full-size true-blue IBM keyboard.

The NoteBrick 486's display is small (5.2 by 6.8 inches), but it's clear and easy to look at. Ergo gives you a Logitech mouse with the NoteBrick 486 and throws in a copy of AddStor. You can use the latter to turn a 170-MB drive into (roughly) a



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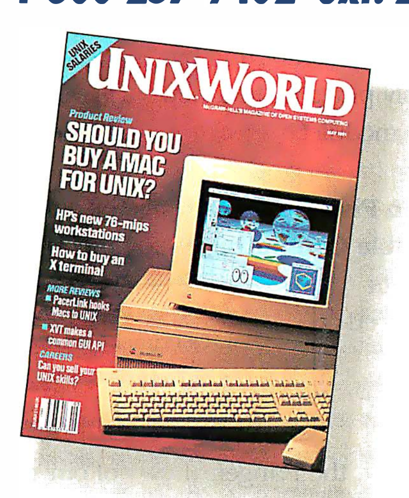
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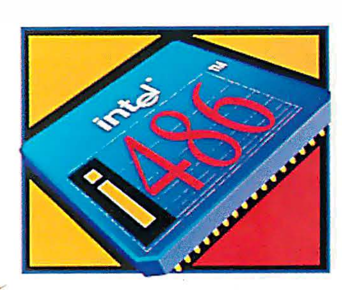
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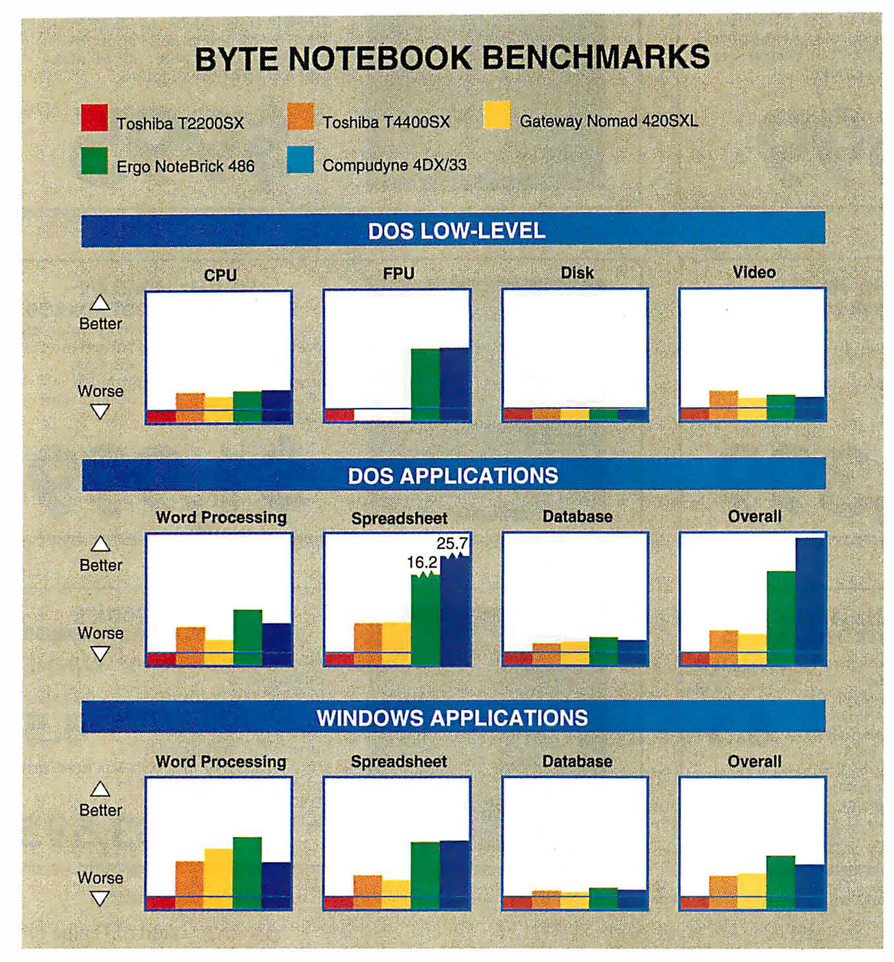
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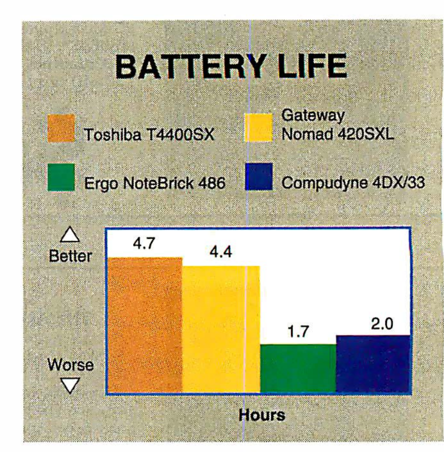


All results are indexed, and higher numbers indicate better performance. For each index, a Toshiba T2200SX running DOS 5.0 and Windows 3.0 = 1.

The BYTE low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component. The results of these tests can help you identify the relative performance of a given subsystem and determine where performance bottlenecks may lie. For a complete description of these tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990 BYTE. The BYTE low-level benchmarks, version 2.2, are available in the byte.bmarks conference on BIX, or you can contact BYTE directly.

BYTE's application performance suite measures the performance you can expect to see running a given application category under a given operating environment. We test under two environments: DOS 5.0 and Windows 3.0. We test three application categories for each environment, running test scripts using the following programs: Word Processing: WordPerfect 5.1 and Lotus Ami Pro 2.0; Spreadsheet: Lotus 1-2-3 release 2.3 and Microsoft Excel 3.0a; and Database: Software Publishing Superbase 4 version 1.3 and Borland dBase IV. The data files and test scripts are available from BYTE.

The similarly configured Compudyne 4DX/33 and Ergo NoteBrick 486 (both with a 33-MHz 486DX processor) competed for the top spot on our performance benchmarks, splitting the DOS and Windows application suites. However, the spreadsheet application test is floating-point-intensive, so the DX machines have a strong advantage; low-level CPU benchmarks provide a more accurate performance comparison.



The Toshiba T4400SX and the Gateway 2000 Nomad 420SXL stood out in BYTE's battery-life tests.

340-MB drive through file compression. Ergo also preinstalls DOS 5.0 and Windows 3.1.

Gateway 2000 Nomad 420SXL

The Nomad marks Gateway 2000's entry into the notebook market. The computer is a TI design and looks exactly like a TI TravelMate 3000. Gateway offers a series of 486-based Nomad machines, ranging from the low-end 420SXL ($2795) to the top-of-the-line 425DXL (a 25-MHz 486DX that costs $3495). In its 420SXL configuration, the Nomad is the least expensive of these notebooks; it's also one of the lightest and slimmest, and it's quiet. Not surprising, it's also a little slower than its more fully featured competitors, as you can see from the benchmark results.

While the price/performance trade-off is reasonable, the Nomad's keyboard is its weak point. The PageUp, PageDown, Home, and End keys are also the cursor keys. You hold down an Fn modifier key to choose between these sets. The Insert and Delete keys are in the upper right corner of the keyboard, not the lower right.

The Nomad's screen is the largest of the four (6 by 7.9 inches). The screen is easy to read and has a toggle switch for reverse video. The Nomad has a connector for an external VGA monitor and one for an external keypad. You can also use an external keyboard with an optional adapter.

Nomad's pointing device is a hand-held trackball. Only about 1½ inches square, the Nomad mouse lets you use your thumb to move the mouse cursor. One button on the pointer represents "click and hold," but I found the device unwieldy. Gateway loads DOS 5.0 and Windows 3.1 for you.

Toshiba T4400SX

Toshiba is an old hand at making notebook computers. The T4400SX continues the tradition of good keyboard layout and feel and good display quality that made the T2200SX such a dazzling success. In the past year, however, Toshiba's competitors have created new machines that also have good keyboards and displays. The T4400SX is a solid machine, and it's the only notebook in this collection to offer a color screen as an option, but its high price ($4349) makes it vulnerable to these new competitors.

The T4400SX is heavier and thicker than the Nomad and 4DX/33 but lighter and smaller than the NoteBrick 486. The PageUp, PageDown, Home, and End keys are dedicated. The Insert and Delete keys are in the right place. The Control, Caps Lock, and tilde keys are in unfamiliar locations, however.

The only major problem with the T4400SX is its power switch. Located on the left side of the case, the recessed switch requires a lot of effort to operate. The brightness and contrast controls are also poorly placed; they are in an exposed

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position, easily bumped, and you'll probably have to readjust them each time you turn on the T4400SX.

The T4400SX offers a resume mode that can be activated through the power switch. When enabled, the resume mode puts you back exactly where you left off when you powered down. This is convenient, unless you use your notebook on a LAN. When you power up, the network software doesn't realize it has lost touch with the file server. And if an application crashes, the power switch resumes back to the same crash. Pressing a special reset button on the back of the T4400SX, or disabling resume mode entirely, solves this problem.

The T4400SX has an expansion bus, one serial and one parallel port, an optional external keyboard connector, and an external VGA port. You can put an internal modem in the machine. Toshiba doesn't supply a mouse or Windows 3.1 with the computer.

Noteworthy Notebook

When I decided to buy one of these notebooks, I picked the Compudyne 4DX/33. For me, the size of the hard drive, the processor speed, the clarity of the screen, and the built-in trackball were deciding factors. Of course, I'll have to put up with the keyboard when I travel, but at my desk I'll use an IBM PS/2 keyboard and VGA monitor.

The new notebook arrived yesterday. I don't expect I'll need to use my PS/2 Model 80 office machine ever again. ■

Barry Nance, a programmer for the past 20 years and a BYTE contributing editor, is the author of Using OS/2 2 *(Que, 1992),* Network Programming in C *(Que, 1990), and* Introduction to Networking *(Que, 1992). He is the editor for the IBM Exchange on BIX, where you can reach him as "barryn."*

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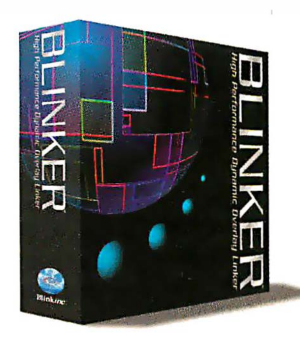
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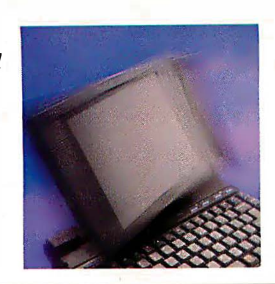




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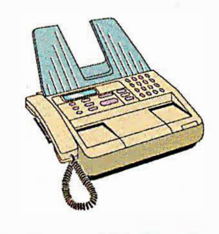
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APPLICATION

A New Illustrator for Windows

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Although Adobe Systems' Illustrator 4.0 for Windows is a welcome improvement over the original version for Windows, there are enough missing or poorly implemented features to make this upgrade less than spectacular.

Still, several improvements make the program an important tool for graphic designers and technical illustrators. By bundling Illustrator 4.0 with TypeAlign, Adobe's type-manipulation program, the company addresses some of the missing type-manipulation features found in competitors' programs. Illustrator comes with Adobe Type Manager 2.02 and 40 Type 1 PostScript fonts. Also included are Adobe Separator, a color-separation program, and a version of Adobe Streamline, the bit-mapped graphics tracing program.

Some of Illustrator's new features include the ability to work on illustrations in preview mode, dynamic zooming, better font control, and improved color separation through the Adobe Separator program. Also much improved are the on-line help facility and screen-refresh rates. Another nice new touch to the interface is a floating tool palette that can be resized or made large for high-resolution monitors.

Adobe claims that the program has been optimized for 386 and 486 machines. The program requires a 386 or higher processor, 4 MB of RAM, a hard drive, and a VGA monitor. Experience recommends at least a 33-MHz 386 with 8 MB of memory. Illustrator will not run on an EGA monitor or any other monitor that does not have square pixels (i.e., 640 by 480, 1024 by 768, and so on). If you try to run the program on such a monitor, an error message will warn you of the discrepancy.

Screen 1: *With TypeAlign, you can manipulate text in almost unlimited ways. Adobe Illustrator 4.0 lets you link type to a curved path and offers precise control over tracking and kerning of type.*

Screen 2: *With Illustrator's Blend tool, you can blend virtually any shape into another. You can also use the tool to create blends of one shade into another within a given object.*

Color Preview

One annoying problem with Illustrator in previous Windows and Macintosh versions was the need to toggle back and forth between artwork mode and preview mode. You would draw in artwork mode and view the finished work in color by making a menu selection that toggled the screen into preview mode. This was necessary because of the slowness in screen redrawing rates when the full-color screen had to be refreshed each time an element in the drawing changed. Illustrator 4.0 for Windows lets you manipulate work in preview mode in full color, albeit with slower screen refresh, or continue, as before, to work in artwork mode (with a faster screen refresh) and toggle into preview mode to view the final product. The Mac version still suffers from this toggle boggle.

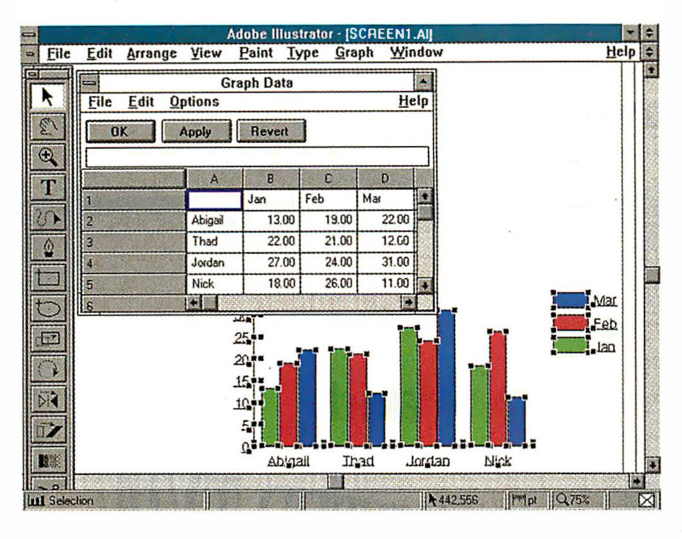
One conspicuous omission, available in rival Aldus FreeHand, is a multiple Undo function. With Illustrator, a single undo is all you get, while FreeHand has up to 99 undos, a valuable feature for the less-than-perfect graphic designer. But beware: Under certain conditions, the Undo function doesn't work at all. This is most noticeable when you go back and forth between preview and artwork modes. If you create a certain effect in artwork mode and then view it in preview and discover you don't like it, you're in for a surprise when you return to artwork mode to try to undo it—you can't. The Undo function is also disabled when you use certain menu items.

Better Type

Illustrator 4.0 and TypeAlign offer much-improved type manipulation and control. Although neither supports TrueType, and both work with only Adobe Type 1 PostScript fonts, the combination of the two programs gives you greater control over type manipulation. With TypeAlign, text can be stretched, pulled, and manipulated in ways limited only by your imagination. Illustrator itself lets you link type to a curved path (see screen 1) and offers precise control over tracking and kerning of type. Type can be stroked with one color and filled with another and can be converted to outlines and filled with an image or gradient. Unfortunately, images must be pasted into text one letter at a time, so the process can get tedious.

Illustrator lacks CorelDraw's ability to create instant 3-D type effects, but you can achieve the same results with a few added steps. If Adobe could see its way clear to support TrueType, Illustrator 4.0 could take advantage of all the TrueType fonts included with Windows 3.1.

The new release of Illustrator introduces dynamic panning and zooming. Although these are much-needed features, there is a



Screen 3: *You can enter data manually into an Illustrator spreadsheet and automatically generate a chart or graph.*

drawback. The screen goes blank during panning, making it difficult to judge how far the page has been moved. Zooming works much better. You select the magnify tool and draw a rectangle around the area you want to zoom in on. Zooming is almost instantaneous.

With Illustrator's Blend tool, you can blend virtually any shape into another, as in the example of the square blended into a circle (see screen 2). You can also use the tool to create blends of one shade into another within a given object.

Working with Color

Adobe has provided a program to create color separations from Illustrator files. Adobe Separator is a stand-alone application that lets you create custom color separations from your Illustrator files for four-color-process output. Illustrator also supports several color-matching systems, albeit in a cumbersome way. Instead of building color matching into the software, Adobe provides several files that have color-matching systems as custom colors. You must open the document containing the color-matching system of choice, make a copy of it, and create your illustration on the copy of that document.

Color-matching systems supported include Pantone, Toyo, Focoltone, and Trumatch. You have the option, as always, of creating your own custom ink colors. Illustrator also has the capacity, in conjunction with printed color swatches in the manual, to let you calibrate your monitor to match printed output. Although crude, the method seems fairly accurate.

Illustrator is Super VGA--compatible in its color picker, but something odd happens when you select custom colors. Since a computer is capable of displaying colors that are unprintable using the standard four-color-process method, color pickers geared for printed output are usually designed to display CMYK equivalents. In this way, users receive an on-screen approximation of what their printed output will look like. Since Adobe's color picker is RGB-based, it is possible to select custom colors that are unprintable. Adobe offers no explanation for this anomaly in the documentation for Illustrator.

Illustrator's simple, elegant interface continues to be its strong suit. All similar structured-drawing programs support Bézier curves, one of the basic constructs of the PostScript PDL (page-description language), but Illustrator's entire interface is based on the creation, linking, manipulation, and control of these curves. There are tools to draw and manipulate freehand curves and combine them with lines and shapes to create complex illustrations. While the Bézier model may prove daunting to the novice, once you've grasped the concept, you'll have a handle on the true power of the program.

An Illustrator's Guide

There is an excellent tutorial that takes you through Bézier-curve fundamentals, and the accompanying examples on disk help beginners grasp Illustrator's unique approach to drawing and shape manipulation. A separate Beyond the Basics manual proceeds step-by-step through more complicated illustration techniques.

Unlike FreeHand, Illustrator lacks any type of layer management or control. In complicated illustrations, this lack of layer management can have serious consequences. Since the order in which layers exist on the page determines their characteristics and whether they obscure a layer underneath them, some kind of approach to layer management is very important in any structured-drawing program. Given Illustrator's lack of layer management, it is at times almost impossible to manipulate certain objects in large, complicated illustrations. Adobe suggests grouping similar objects together, but this is not a solution. Until the problem is addressed, a lack of layer management will remain a serious flaw in Illustrator 4.0.

Another serious problem I encountered with Illustrator 4.0 is its inability to import EPS (Encapsulated PostScript) files from other programs, notably PhotoStyler and CorelPhoto. The images seem to import error-free, but they are not viewable. Adobe's technical support acknowledges this problem and says a bug fix is in the works.

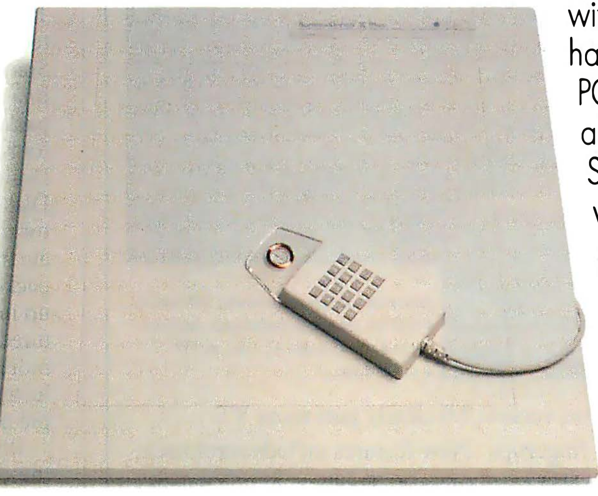
On the matter of technical support, Adobe seems strangled by its own success. It took two separate sessions of over 45 minutes each of auto-dialing Adobe technical support before I was put through. Then it took an additional 10 minutes before an actual technical representative came on the line. The representative was knowledgeable and courteous but admitted that the company can't handle the volume of calls it receives. Although the manuals and tutorials are well written, there are occasions when you'll need to get through to

BYTE ACTION SUMMARY

- **WHAT ILLUSTRATOR 4.0 IS**
  A professional design tool for creating precise illustrations and single-page designs.
- **LIKES**
  Lets you view and edit color illustrations directly; has improved type manipulation and control.
- **DISLIKES**
  Lack of layer management.
- **RECOMMENDATIONS**
  Despite several omissions and a few bugs, Illustrator 4.0 is a powerful tool designed for ease of use.
- **PRICE**
  $695
- **FOR MORE INFORMATION**
  Adobe Systems, Inc.
  1585 Charleston Rd.
  P.O. Box 7900
  Mountain View, CA 94039
  (415) 961-4400
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technical support. The present system is not satisfactory.

Charts and Graphs

An additional feature of Illustrator 4.0, of interest to users of business graphics, is the built-in charting capability. You can import spreadsheets into Illustrator and automatically generate a wide variety of charts and graphs. You can also enter data manually into an Illustrator spreadsheet (see screen 3) and generate a chart or graph that way. Legends are linked to their respective values and change automatically if values are changed. A wide range of different chart and graph types includes bar graphs, pie charts, and scatter graphs. Graphic designers should appreciate the ease with which they can create good-looking charts and graphs.

The program also allows you to import scanned artwork as templates. Templates can be any bit-mapped image in TIFF, PCX, or BMP format. These images can be traced by hand with Illustrator's drawing tools, or they can be auto-traced with the program's built-in Auto Trace tool. The auto-trace function is not very accurate; the traced illustrations require quite a bit of cleaning up to create an accurate rendition of the image. For a limited time, Adobe is offering Streamline, its higher-quality tracing program, free to purchasers of Illustrator. Adobe should have included the capabilities of Streamline in Illustrator in the first place so it wouldn't have had to bundle it as a separate program.

Illustrator drawings cannot be copied, pasted, or viewed in the Windows Clipboard except as special Adobe PostScript objects. These can be passed from TypeAlign and Streamline into Illustrator, but not the other way around. Text blocks that are imported from TypeAlign to Illustrator via the Clipboard come in as outlines. Illustrator 4.0 can read and write Illustrator files from the Mac and from Adobe's Unix and Next versions of the program and can save in Illustrator 88 and Illustrator 1.1 file formats. Tests confirmed that file compatibility is 100 percent across the Mac and PC platforms.

The Whole Bundle

Adobe includes a fair number of borders, symbols, and patterns with the program. These images provide a shortcut from the tedious work of creating these shapes. Some of the borders and patterns are quite imaginative. Noticeably missing from the package is the cornucopia of clip art and fonts distributed with programs like CorelDraw and Professional Draw from Gold Disk, but this is probably not a drawback for most illustrators, as they prefer to create their own work from scratch. What the package lacks in clip art and fonts it makes up in a simple, elegant approach to structured drawing. In fact, Illustrator is much more a tool for creating professional illustrations than for putting together a simple poster or brochure.

Illustrator 4.0 is a welcome addition to the collection of Windows-based structured-drawing programs on the market. While it does not have the wealth of features, clip art, fonts, and ancillary programs offered by CorelDraw 3.0 and several other competitors, it is an excellent illustration tool designed for ease of use. Despite several omissions and a few bugs, the program is a powerful tool for the technical illustrator and professional graphic designer. ■

Cal Vornberger is a graphic designer and software developer who specializes in multimedia applications and presentations. He can be reached on BIX c/o "editors."

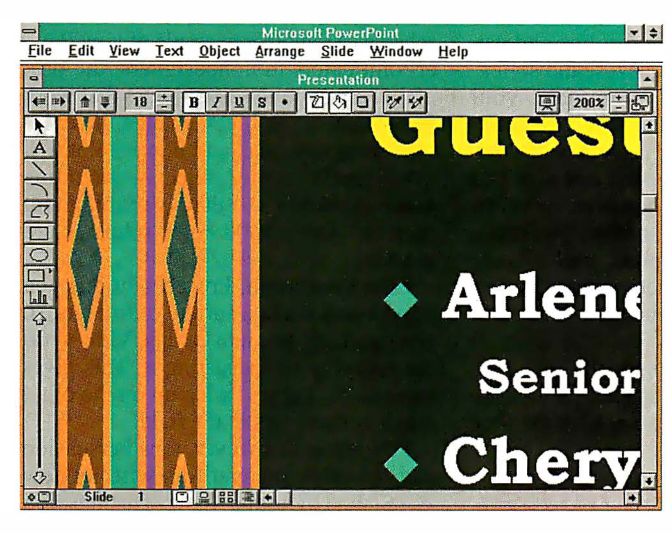
APPLICATION

A Power Boost for PowerPoint

SHELLEY CRYAN

With the release of version 3.0, PowerPoint proves you don't need well-honed design skills and a fondness for studying software manuals to create stunning slide presentations on your computer. With a host of new features, including a convenient toolbar, improved drawing and text-handling capabilities, and support for OLE (Object Linking and Embedding), PowerPoint 3.0 represents a sweeping upgrade. Microsoft makes up a lot of ground lost in the two years since PowerPoint's last major upgrade.

PowerPoint 3.0 requires Windows 3.1, and you'll need at minimum a 286 with 2 MB of memory. Microsoft recommends a 386 with 4 MB. Working without a color monitor is possible, because you can select colors by name, but this is akin to buying mail-order dress shoes—you'll be satisfied only if you know exactly what you want or if you're lucky. Make some room on your hard drive; PowerPoint fills 5 to 17 MB, depending on the options you install.



The new version of PowerPoint includes an improved toolbar. The toolbar offers convenient access to commonly used tools and single-click formatting for indentation, text styles, and text sizes.

The Right View

PowerPoint 3.0 helps even the occasional presenter to create professional-looking slides, overheads, or on-screen presentations. You supply the information; PowerPoint eases you through design and production.

PowerPoint offers you four "Views" in which to work. Outline View lets you type your ideas in outline form, which PowerPoint uses to generate slides. In Slide View, you can type directly on the on-screen slides themselves. Here, you customize the look of your slides by applying colors, formatting text, and adding charts, graphs, and drawings. In Slide Sorter View, you can change the order in which the slides appear by dragging slides around with the mouse. Speaker's Notes View lets you jot down things to remember to mention when giving the final presentation. Version 3.0 not only makes all this easier to do than in the previous version, but it offers you a wider variety of options as well.

The most visible change found in each of the Views is the new toolbar. It gives you quick access to frequently used commands, saving you the hassle of using pull-down menus.

Buttons on the toolbar let you format text and toggle easily between magnification levels. An especially helpful set of buttons lets you manipulate relative text placement; for instance, you can move paragraphs around and adjust indent levels. These buttons are much easier to use than the sometimes confusing methods required in top competitor Aldus Persuasion. The toolbar is intelligently designed, although it lacks a text-alignment button.

Master Plan

PowerPoint 3.0's most significant improvements are in its Slide View. As in the previous version, you create and format a single Slide Master, which dictates the format of every slide, but 3.0 offers much more flexibility. The Slide Master now includes both a Master Title and a Master Body that you format separately, and you can alter the Slide Master at any time.

This scheme of a single Slide Master helps to make for a surprisingly short learning curve. It's easy to remember that anything that's on the Slide Master—logos, artwork, and so on—will show up on every slide. However, it's only useful when most of your slides will be formatted the same way, since you'll have to manually set up the slides that vary from the master. This isn't difficult, but it's tedious if you've got more than a handful to adjust.

In contrast, Aldus Persuasion gives you several slide masters, and each one has two parts: a background and a foreground. This scheme offers greater flexibility, especially if several formats will be used more than once. However, it's more complicated, especially if you don't use Persuasion frequently enough to remember how it works.

Other changes in PowerPoint's Slide View include an enhanced set of drawing, text-editing, and graphing tools. Can't draw a perfect shape on demand? Rather not dredge through a clip-art collection to find one? The new Shape Tool is a boon. It's really 24 tools in one: You can use it to create a myriad of stars, arrows, circles, cubes, triangles, and star bursts, and you can change the shape of existing objects with the click of a mouse.

Text editing is now done with a single tool, which is automatically activated when you highlight an object and start typing. The typographic formatting controls include the usual suspects, and using them is straightforward.

Like other programs in this category, PowerPoint does not include high-end text-handling features such as kerning and rotating. You can, however, create embossed text and can use any character of any size or color as a bullet.

The graph tool is not really a tool like the others. When selected, it launches a separate, embedded application called Microsoft Graph. This is the same full-featured graphing program featured in Microsoft Project, Word, and Works. It offers 84 different graphing styles, including all the standard 2-D and 3-D styles and then some. Graphing is probably the hardest aspect of PowerPoint to learn, but the payoff is in the amazing degree of control that you have over the look of your graph. Look no further than PowerPoint if you require sophisticated graphs in your presentation.

continued

Text and Templates

If you've worked with previous versions of PowerPoint, you will be especially pleased with the way it now handles templates. A template serves as a collection of styles to be used throughout a presentation. These styles include background colors and patterns, fonts, text colors, sizes, and styles.

When you "apply" a template, your presentation takes on the style characteristics of that template. The beauty of PowerPoint's implementation is that now you can apply or replace a template anytime. Existing slides, as well as slides you create after you apply a template, will all take on the template's characteristics. This lets you instantaneously change the look of your presentation.

PowerPoint comes with 160 predesigned modifiable templates, which are indispensable if you have neither the time nor the inclination to make your own. It's particularly convenient that templates and presentations are the same type of file, so any presentation can also serve as a template.

Integral to any template is a color scheme. As another example of how PowerPoint caters to nondesigners, the program helps you to select colors that work well together. You can change the color scheme at any time, and PowerPoint will intelligently recolor objects—including graph elements—so that everything still matches. Over 5000 color schemes are available.

Like Persuasion, PowerPoint lets you import outlines in a variety of formats, so you can dump text into Outline View without rekeying or translating it. This gives these two programs a leg up on the other major competitors in the field.

PowerPoint, however, tops Persuasion and the other competitors with its new WYSIWYG Outline View. This lets you format text in either Slide or Outline View, and the different fonts, sizes, and text styles show up in Outline View. Additionally, small icons next to each slide title in Outline View indicate if there are any graphics on the corresponding slide. These visual cues make it significantly easier to edit quickly in Outline View.

Not surprisingly, PowerPoint takes advantage of Windows 3.1 technology. With full OLE capabilities, PowerPoint lets you embed pictures, graphs, and sound from other applications into your presentation. Simply double-clicking on the embedded object automatically loads the external application that created the object. This worked well with compliant applications, including the Sound Recorder and Paintbrush.

Font handling in PowerPoint is also much improved. Unlike with PowerPoint 2.0, you can use TrueType fonts instead of fonts created just for PowerPoint. Additionally, you can save the fonts with your presentation, which is helpful if you need to run your presentation on someone else's computer.

Making the Pitch

In the event that you want to show your presentation on a computer that doesn't have PowerPoint loaded, you can now use the PowerPoint Viewer. A run-time version of PowerPoint's slide-show mode, Viewer can be distributed freely with presentations. With beefed-up slide-show transition effects, like a "flying bullets" feature that makes your bullet points slide into place when a new slide comes on-screen, the opportunity to look good is certainly compelling.

Like Persuasion, PowerPoint only got it half right, though. It should also include a Viewer to run PC presentations on a Macintosh, which would provide real distribution flexibility. Because Microsoft plans to release an upgrade to the Mac version of PowerPoint in the fall and claims cross-platform portability, a Macintosh Viewer for PC presentations should hardly be a stretch.

PowerPoint tops Persuasion and the other competitors with its WYSIWYG Outline View.

While many of its major features have been greatly improved, PowerPoint also shines in the details. A spelling checker, extensive on-screen help, and an automatic Smart Quotes option (to automatically turn straight quotation marks into curly quotes) all help to make the program easy to use. The Print dialog box, however, could be improved to let you print out all parts of a presentation with one command, instead of making you select notes, slides, handouts, and outlines individually.

PowerPoint 3.0 delivers a powerful tool for creating great-looking presentations quickly for people who have little design expertise. The broad flexibility to easily change templates, masters, and colors at any time will be welcomed by businesspeople who select designs by trial and error. Support for OLE is a real time-saver, as is the ability to import text and data in a variety of formats.

PowerPoint 3.0 lets you concentrate on your presentation's content rather than design and production. Is there a presentation in your future? At $495 and with excellent documentation, PowerPoint is a good choice for your software library. ■

Shelley Cryan runs a consulting business that helps companies incorporate computer-based technologies to boost productivity. She holds an M.B.A. in finance and marketing from the University of Chicago. She can be reached on BIX c/o "editors."

BYTE ACTION SUMMARY

WHAT POWERPOINT 3.0 IS
A Windows 3.1 presentation graphics program geared toward business presenters.

LIKES
It lets you change text and background formats quickly and easily; it has a convenient toolbar.

DISLIKES
It cannot create more than one slide master per presentation, so you'll have to manually set up the slides that vary from the master.

RECOMMENDATIONS
Despite its many features, PowerPoint is extremely easy to learn and use, making it well suited for people who are not professional presentation designers. It will satisfy the needs of almost any business presenter. Highly recommended.

PRICE
$495

FOR MORE INFORMATION
Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(206) 882-8080
fax: (206) 936-7329
Circle 1221 on Inquiry Card.

SYSTEM

IBM's New System Speaks for Itself

TOM YAGER

Although responsible for the PC era, IBM has rarely led the market that it created. Now, IBM is hoping to recapture some of the glory of the old days with innovation in a new market: multimedia PCs.

Big Blue's latest PS/2 is the first in a line of unique multimedia-capable systems. Dubbed the PS/2 Ultimedia Model M57 SLC, this new system brings a few surprises to the multimedia PC party. IBM's XGA display adapter, its fine-sounding integrated audio, the fast Micro Channel bus, and its helpful front panel raise the M57 SLC above similar systems. Without better software support, however, the M57 SLC will face stiff competition from the rest of the multimedia PC crowd.

Looks Aren't Everything

Like all PS/2s, the M57 SLC is no beauty queen. But behind the Volvo-esque facade sits a solid machine. Its most notable feature (see the photo) is its multimedia front panel. Unlike systems built from MPC upgrade kits, the M57 SLC brings fully mixed audio directly to the front panel through a marvelously accessible quarter-inch headphone jack. A microphone jack and a volume control also share the panel. The CD-ROM drive has its own eighth-inch headphone jack and volume control.

The M57 SLC is designed around a 20-MHz 386SLC, IBM's own implementation of Intel's 386SX that includes an on-chip cache. Processing speed is fair, and a high-speed hard drive contributes to solid overall performance (see the figure). The compact motherboard also holds SCSI and floppy drive controllers and integrated VGA, serial-port, and parallel-port circuitry.

The system's Micro Channel bus rises vertically. Of the six total slots, four are free, one holds an XGA adapter, and the other contains an audio board. The standard sound board is IBM's M-Audio digital-audio capture-and-playback board. A ribbon cable connects this board to the system's front panel, making digital audio feel more like a designed-in feature than an accessory. The board's back panel has a set of eighth-inch connectors labeled only by single letters. This and the somewhat unclear symbols used on the front to signify power and microphone input make the machine a little more confusing to use than it needs to be.



The PS/2 Ultimedia Model M57 SLC features handy front-facing microphone and headphone jacks and a volume control. An internal speaker lets you listen to multimedia presentations without headphones.

It's in There

The system I reviewed was pretty well decked out. Standard features include the 3½-inch 2.88-MB floppy drive and the 600-MB SCSI CD-ROM drive. The standard configuration ($5995 without monitor) includes 4 MB of RAM and a 160-MB SCSI hard drive, but the system that I reviewed was boosted to one with 16 MB of RAM

BYTE ACTION SUMMARY

WHAT THE PS/2 ULTIMEDIA MODEL M57 SLC IS
A 386SLC-based PS/2 with integrated digital audio and CD-ROM.

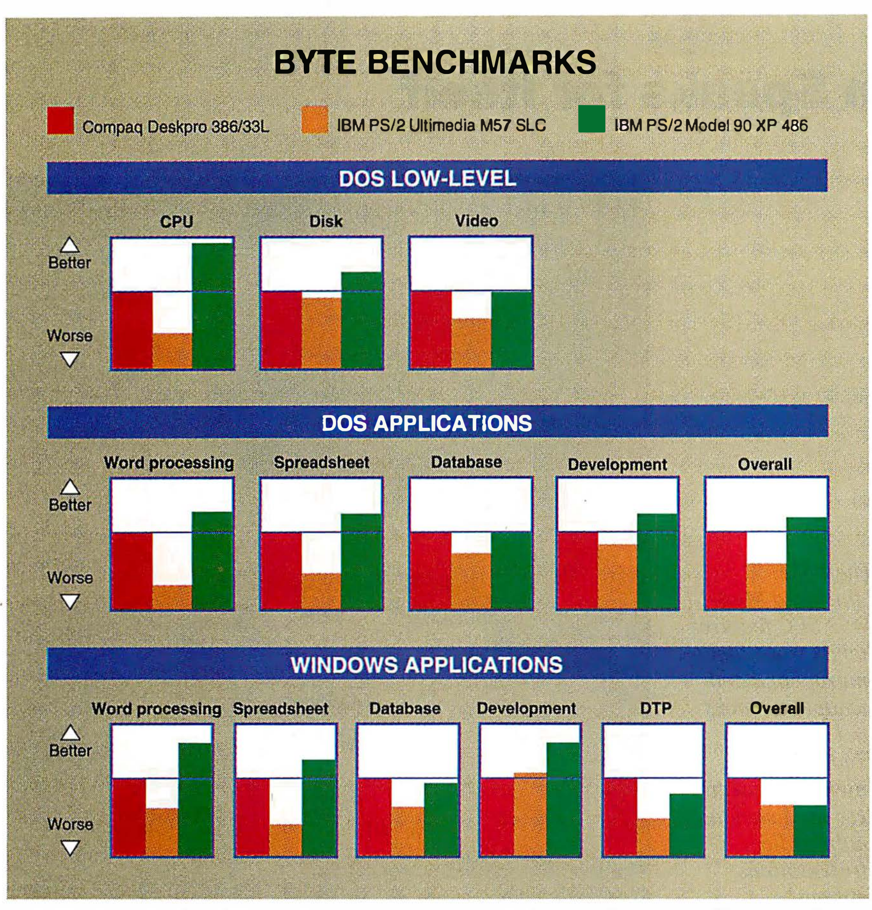
LIKES
Easily accessible front-panel jacks and controls, dual independent digital-audio channels, and internal speaker.

DISLIKES
Much of the software is not quite solid; MIDI support is poor.

RECOMMENDATIONS
Once software is stabilized, this will be a high-quality multimedia system with several advantages over the rest of the crop.

PRICE
$6945 (includes an 8515 monitor)

FOR MORE INFORMATION
IBM Corp.
1133 Westchester Ave.
White Plains, NY 10604
(800) 426-9292
Circle 1233 on Inquiry Card.



All results are indexed, and higher numbers indicate better performance. For each index, a Compaq Deskpro 386/33L running Compaq DOS 5.0 and Windows 3.0 = 1. The overall index is the average index of the individual tests.

The BYTE low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component. The results of these tests can help you identify the relative performance of a given subsystem and determine where performance bottlenecks may lie. For a complete description of these tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990 BYTE. The BYTE low-level benchmarks, version 2.2, are available in the byte.bmarks conference on BIX, or you can contact BYTE directly.

BYTE's application performance suite measures the performance you can expect to see running a given application category under a given operating environment. We test under two environments: DOS 5.0 and Windows 3.0. We run test scripts using the following programs: Word Processing: WordPerfect 5.1 and Lotus Ami Pro 2.0; Spreadsheet: Lotus 1-2-3 release 3.1+ and Microsoft Excel 3.0a; Database: Software Publishing Superbase 4 version 1.3 and Borland dBase IV; Development: Borland Turbo Pascal for Windows and Microsoft C 6.0; and Desktop Publishing: Aldus PageMaker 4.0. The data files and test scripts are available from BYTE.

With its cached 386SLC processor and high-speed SCSI disk, the M57 SLC stacks up at about 60 percent the speed of a 33-MHz 386 system on most tests—slightly faster than the typical 20-MHz 386SX.

(which adds another $1240 if you buy SIMMs from IBM). An 8515 monitor costs an additional $950. As an aside, I appreciated IBM's provision of an extra connector on its internal SCSI cable. There are other nice touches, too, like a plastic loop to help lift the SCSI terminating resistor out of its socket and a front-facing oblong speaker that's hooked to the audio board (so it can actually say something besides "beep").

The M-Audio capture-and-playback adapter represents a departure from the audio boards commonly seen in multimedia PCs these days. The difference is the DSP (digital signal processor). Even the MIDI instrument sounds are delivered by the DSP (rather poorly, I'm afraid). Perhaps most valuable are the board's two independent audio tracks. This pair compensates somewhat for the not-so-hot DSP synthesizer by allowing digitized music to play underneath a separate voice track. This feature was frequently highlighted in IBM's demonstrations; the music ran without interruption while the demonstration software loaded and played multiple foreground voice files. The digitized-audio quality is adequate, and I was particularly pleased with the external speaker's delivery of very clear digitized voice. Music is not delivered as well, but when you listen through headphones, the sound is quite clean.

The system I reviewed included DOS 5.0, Windows 3.0, and OS/2 2.0 on CD-ROM. I was pleased to find that IBM had included the Windows Multimedia Extensions, which were tweaked to provide support for M-Audio, XGA, and the CD-ROM drive. The multimedia drivers for OS/2 were still in beta testing at the time of this writing, and the full-fledged Multimedia Presentation Manager wasn't even hinted at. Still, a popular IBM authoring tool, AVC (Audio Visual Connection), ran fine under OS/2 and had support for most of the system's multimedia components. AVC does not support M-Audio's quasi-MIDI synthesizer, but I didn't miss it. Apparently, neither did IBM: The AVC demonstration entitled "MIDI Jukebox" plays *digitized* audio recorded from a real MIDI synthesizer.

Ironically, the best-supported environment for the M57 SLC at the time of my review was Microsoft Windows. It is a credit to IBM that it swallowed some pride and cooked up pretty solid support for its leading operating-system competitor. I loaded a handful of Windows multimedia applications, including Master Trax Pro, Macromind Action, and Brown-Wagh Curtain Call.

The updated Curtain Call, with its support for the Multimedia Extensions, refused to play any of the sample digital-audio files included in the package. I then found out that the standard Windows Media Player program wouldn't play them either but that the Sound Recorder application would. The same files loaded and played fine on an MPC-upgraded PC. Since both Curtain Call and the Windows Media Player communicate with hardware via a high-level interface that the Sound Recorder bypasses, there are apparently some bugs in IBM's implementation.

Listen Up

IBM's first entry into the multimedia PC market is impressive, but not exceptional. The M-Audio board's ability to handle two distinct tracks of digital audio is a huge help to even simple presentations, and the XGA adapter offers improved display performance.

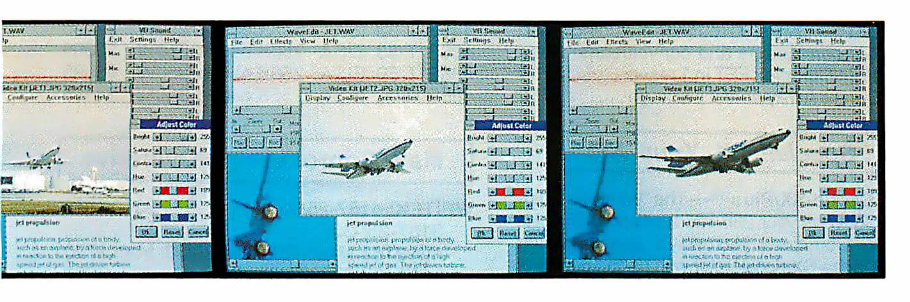
IBM now needs to beef up its Windows Multimedia Extensions support and get Multimedia Presentation Manager out before Microsoft walks away with the entire PC multimedia market. Whatever moves IBM makes in software, the M57 SLC and the Ultimedia PS/2s that follow it should equip IBM to compete effectively in what is fast becoming a crowded market. ■

Tom Yager is the director of the BYTE Multimedia Lab. You can reach him on BIX as "tyager" and on the Internet as "tyager@bytepb.byte.com."

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SOFTWARE

Microsoft's Lucky Number

OTHAR HANSSON

With all the discussion over object-oriented this and that, the only real success story in OOP (object-oriented programming) seems to be C++. With Symantec/Zortech and Borland cleaning up in sales of their Windows-compatible C++ compilers, Microsoft knew its long-standing policy of "C and C alone" would have to go.

After several delays, Microsoft C/C++ 7.0 (or C7 for short) has arrived. Its price and features make it obvious that Microsoft intends to try to recapture the lead it had some years ago when Microsoft C was the only game in town.

C++ Class Library

Arguably the most exciting feature of C7 is the C++ language itself, a topic somewhat beyond the scope of this review. C7 fully supports C++ native compilation, debugging, and profiling. In addition, in the MFC (Microsoft Foundation Classes) library, Microsoft has presented a surprisingly simple and straightforward example of how C++ can be used to simplify development of Windows and MS-DOS applications.

A simple example is provided in listing 1, a sample from Microsoft that consists of the very brief MFC-assisted "Hello, World" program. As you can see, the program relies on a lot of default behavior provided by MFC classes such as `CWinApp` and `CFrameWnd`. The program even uses the `main()` and `winMain()` functions provided by the library, relying simply on the constructor for `CHelloApp()` to initiate the application's interaction with the user.

Microsoft says that the MFC is merely the first in a family of Application Framework Extensions (hence the `afx_` prefix in all library symbols) that will track future Windows developments, including pen-based systems, multimedia, and Windows NT. The future of the library remains to be seen, but it certainly provides a good start. While this is Microsoft C/C++ 7.0 for Windows 3.1, it is important to stress that the library is version 1.00. The initial version of a C++ class library typically suffers from a few oversights, and I would expect changes in future versions of the MFC (luckily, the source is provided for do-or-die modifications).

Keeping Up

One source of future changes is the uncertain state of the C++ ANSI standard, which is still under development. C7 implements the AT&T C++ 2.1 specification, but it deviates from some aspects of later versions. Microsoft claims (correctly) that the upcoming ANSI standard is the only standard worth arguing about, but practically speaking, most other compiler vendors track the AT&T implementations as a de facto standard, and thus the C7 deviations are likely to be a source of aggravation for users.

The first deviation is in the area of templates, which are used to provide a parameterized class facility. For example, with a parameterized list class, it would be easy to define lists of dates, lists of menu items, or lists of any other object type. While the ANSI standard committee argues over possible template specifications and requirements, compiler vendors are simply implementing their own interpretations. Microsoft has chosen a very simple preprocessor that instantiates the template code to use the specific object types.

A similar portability question can be raised over the Microsoft implementation of exceptions. An exception-handling facility can greatly simplify error recovery, which is particularly important in building bulletproof user interfaces. Microsoft provides exception classes and a set of macros that implement a simple exception-handling mechanism, using the C `setjmp` and `longjmp` routines. However, C7 exceptions are not compatible with the implementations chosen by other compiler vendors.

One "extension" that Microsoft did correctly, however, is its implementation of dispatching for Windows message handling. The natural C++ implementation of this is to use virtual functions for each type of message, allowing an object class to override the message handling provided by its parent class. The large number of Windows message types makes this impractical, resulting in large but ridiculously sparse virtual-function tables. Borland C++ works around this problem through a minor but still nonportable language extension. Microsoft found a solution within the language standards by using macros to construct dispatching tables during program initialization.

C++ Documentation

A recent saying has it that while C++ makes it pretty difficult to shoot yourself in the foot (in contrast to C), when it does happen, it blows your whole leg off.

continued

BYTE ACTION SUMMARY

- **WHAT MICROSOFT C/C++ 7.0 IS**
  A C and C++ compiler with tools for creating DOS and Windows applications.
- **LIKES**
  P-code and in-lining for size and speed optimization; Microsoft Foundation Classes library to simplify Windows programming; complete documentation.
- **DISLIKES**
  Still no Windows-hosted tools; deviation from most recent AT&T implementations.
- **RECOMMENDATIONS**
  This is a compiler well worth considering for projects of any size, but you should compare compilers before making a switch.
- **PRICE**
  $499
- **FOR MORE INFORMATION**
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Listing 1: *This brief segment is the complete Windows version of the "Hello, World" program, simplified through use of the Microsoft Foundation Classes Windows class library.*

```
// helloapp.cpp : Minimal MFC Windows app.
//
// This is a part of the Microsoft Foundation Classes C++ library.
// Copyright (C) 1992 Microsoft Corp.
// All rights reserved.
//
#include <afxwin.h>

// Define a window class derived from CFrameWnd
class CHelloWindow : public CFrameWnd
{ public:
      CHelloWindow()             { Create(NULL, "Hello World!",
                               WS_OVERLAPPEDWINDOW, rectDefault); }
};

// Define an application class derived from CWinApp
class CHelloApp : public CWinApp
{
public:
      virtual BOOL InitInstance();
};

// Construct the CHelloApp's m_pMainWnd data member
BOOL CHelloApp::InitInstance()
{
      m_pMainWnd = new CHelloWindow();
      m_pMainWnd->ShowWindow(m_nCmdShow);
      m_pMainWnd->UpdateWindow();
      return TRUE;
}

CHelloApp HelloApp;
// HelloApp's constructor initializes and runs the app
```

Folklore also has it that the number of C++ programmers doubles every seven or eight months. C++ enthusiasts take such statistics as evidence of technological Darwinism. On the other hand, such statistics imply that one out of every two C++ programmers has very little experience with the language.

The weighty documentation (2 cubic feet worth) included in the C7 package does an admirable job of preventing serious injury from the powerful features of C++. Included is a C++ tutorial that is a little too short to present the entire language but, on the other hand, is not filled with the usual empty object-oriented propaganda. Despite its length, it presents a glimpse of the implementation where necessary (e.g., in describing virtual functions).

In addition, the tutorial on the MFC library takes care to introduce C++ idioms and style based on the style used in the library itself. If the MFC turns out to be the first large C++ library you work with, you'll be following a good example.

Compiler Improvements

Independent of the C++ capability, C7 includes several extensions to the mature and stable Microsoft C compiler family. Improvements in code size and speed continue with C7's use of p-code (pseudocode) and function in-lining. Microsoft's long-standing problem—long compile times—has been eased somewhat by the addition of a particularly flexible implementation of precompiled headers. In my tests, both Microsoft's product and Borland C++ 3.0 exhibited comparable compilation speed.

P-code is an old technique for reducing the size of executables. Rather than compile from a high-level language to object code, the compiler can optionally generate object code for a virtual machine, together with an interpreter to emulate the virtual machine. C7 packs code into a stack-based language that abstracts many of the details of 80x86 assembly language. P-code is selectable on a per-file basis or even within files using the `#pragma` compiler directives. For speed-critical sections of an application, standard options can be used to optimize for speed. But for space-inefficient portions of the code, p-code can reduce code size up to 50 percent in some cases, extending traditional code-size optimizations.

Such p-code has apparently been used in the user-interface code of Microsoft Word, Excel, and Project products. For smaller applications, the size of the interpreter may outweigh the code-size reductions. P-code is compatible with the debugger, profiler, and other development tools, but as it is new technology in C7, I would not be surprised to hear of problems with its use.

Function in-lining selects small, frequently called functions and replaces calls to them with "in-line" code for the function, eliminating the overhead of passing arguments and manipulating the call stack. In-line functions are similar to the age-old use of `#define` macros. However, macros have problems with type safety and unexpected parameter-passing semantics. C7 extends the in-lining implementations of most ANSI C and C++ compilers by allowing the programmer either to specifically request that a function be in-lined or to ask the compiler to search for opportunities for in-lining optimization.

Many compilers will ignore the in-line keyword if the function is too complex. Some compilers will not in-line functions that have even a single conditional or looping statement. In this and many other areas, Microsoft has wisely given the programmer a lot of welcomed flexibility in code optimization.

Finally, C7 uses precompiled headers to reduce the overhead of repeatedly parsing header files during compilation. The overhead cost of large or deeply nested header files is a major problem with Windows programs and is particularly frustrating because many header files never change during the course of a development effort.

C7 allows the programmer to "snapshot" the state of the compilation at any point in a source file, typically after the stable header files have been parsed. This saved precompilation can then be used the next time that source file is compiled. In contrast to other compilers, C7 can precompile executable code as well as declarations.

Environment Improvements

C7 introduces several improvements to both the CodeView debugger and the Programmer's Workbench. CodeView now supports remote debugging, overlapping windows, and faster loading of debugging information. The Programmer's Workbench has a new class browser and extended

cross-referencing facilities. In addition, thanks to the Workbench, it has never been easier for novices to start a new project and get the make-file and compiler options correct.

Microsoft has by no means abandoned MS-DOS development and/or users. All the programming tools are MS-DOS applications. The majority of the MFC library is independent of Windows. This includes all the expected data structures—such as lists, arrays, strings, and "maps"—as well as well-designed support for persistent objects, debugging, tracing, and exception handling.

There are aspects of the development environment that could benefit greatly from a GUI, however. It is somewhat ironic that very few of the tools for developing Windows applications are actually Windows applications themselves. Cynics would say that Windows development must be much more difficult than compiler vendors claim or that the Windows environment is simply not as useful as Microsoft says. Many programmers still want lean and mean tools, not pull-down menus and what they perceive to be sluggish response. I for one eagerly await the advent of Windows class browsers, debuggers, and profilers.

Big and Beefy

As someone who has been using Microsoft C since 1986, when the best that could be said about it was that there was nothing better available, I'm gratified to see C7 up the ante in the C and C++ development tools–feature war. Microsoft's C7 is the classic "power tool," thanks in large measure to its 10,000 pages of documentation and the alphabet soup of options that it provides.

Although its thorough and readable documentation (particularly for C++) and its simple and well-designed class library make it an option for small projects, C7's appeal is clearly to the serious, large-scale development project. I would suggest a head-to-head comparison of different compilers on your application before switching. The applicability of the supplied classes and tools to your particular needs should be the most important factor, and the current price wars make such a comparison feasible. ■

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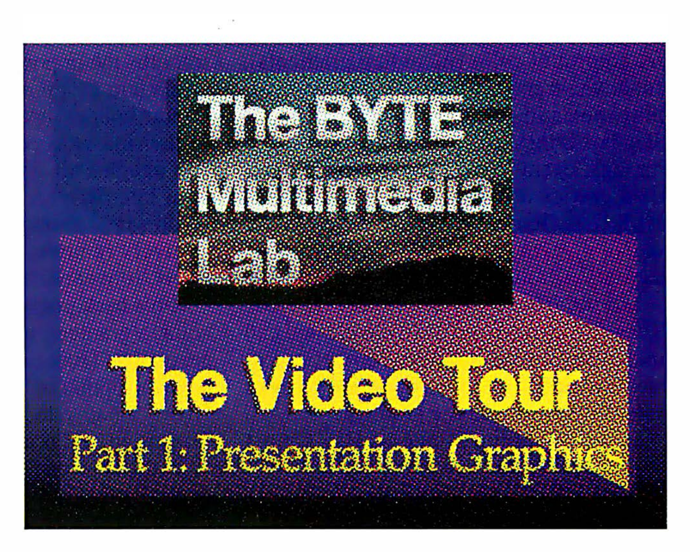
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APPLICATION

Animation Energizes Rio's World-Class Graphics

TOM YAGER

If the current excitement over multimedia has done anything, it's helped open the eyes of potential users to the value of using technology to present information. Sometimes overlooked amid all the hoopla is one of the simplest ways to attract attention: 2-D color graphics. AT&T Graphics Software Labs offers an impressive way to create 2-D presentation graphics. It's called Rio, and its latest incarnation, version 5.20, adds the allure of animation to what was already a world-class tool.



Gradients, transparency, shadows, image mapping, antialiasing, and scalable kerned text, all shown here, are standard in Rio. Rio's unique interface speeds the creation of even complex scenes like this one.

Hanging a Tag

Rio uses 2-D shapes—polygons, ellipses, and text—to represent images of any complexity. You draw, color, and place these shapes as if you were working with shards of construction paper. When viewed together, they can become a convincing vision of anything, real or imagined.

Rio makes no distinction between drawing and preview modes. Everything you draw in Rio typically appears on the screen as it will appear in the finished image. Each element of a drawing—each shape or text phrase—maintains its own identity and carries with it a set of attributes that you can view or change at any time. Rio lets you declare default attributes for the major object types; all circles, for example, can start out yellow and with a shadow. Rio will apply solid colors, gradients, and image maps. Objects can be transparent to any degree and can cast shadows of variable depth, color, and transparency.

Rio includes a small (but expandable) assortment of proprietary scalable fonts. The entire drawing, called a *scene*, is stored on disk in a resolution- and device-independent format. A drawing can be rendered to the screen, to an external device such as a printer or a film recorder, or to a file for later processing. Rio optimizes its output according to the target device, applying antialiasing and dithering to produce smooth, high-quality images.

Finally, with the Animator option installed, you can set your Rio scenes in motion. Animations can be either recorded directly to videotape for the best-quality results or written to a file.

Ticket to Rio

Installing Rio isn't difficult, but it does take some thought. The latest revision of the package includes support for VGA (VESA [Video Electronics Standards Association] compatibility is needed for 256 colors and higher resolutions) and the full line of Truevision 16-, 24-, and 32-bit color display cards. The Truevision cards offer the highest-quality immediately viewable results, but a VGA and a secondary output device (e.g., a color printer or film recorder) are just as effective for hardcopy or slide presentations.

I chose to focus on Rio's strength when used with Truevision cards. I used the BYTE Multimedia Lab's PC system with an ATVista, a 32-bit color card with 4 MB of memory. The destination for much of my work in the lab is video, so the ATVista was aided by Truevision's VidI/O Box, a two-way RGB–to–recordable video converter. This not only paved the way to record my Rio still scenes and animations, but also allowed me to use Rio's image-capture capabilities (more on that later).

Rio runs under DOS but uses Phar Lap's DOS Extender to gain access to extended memory. GSL recommends at least 6 MB of RAM, and a 386 or 486 processor is required (a math coprocessor is strongly recommended for 386-based systems). Input-device support covers popular mice and graphics tablets. Rio will also converse with an amazing number of scanners, printers, film recorders, and VCR controllers, with all the device support internal to Rio.

The rest of the Multmedia Lab's test setup for Rio included a Panasonic AG-7750 Super-VHS video recorder, a Diaquest DQ-422 VCR controller card, and a Videomedia V-LAN VCR controller. The ATVista's output was connected to a Panasonic 13-inch professional video monitor. These things are valuable for video and animation work; a VGA system is all that's needed for basic graphics work.

The Smart Canvas

Rio's interface is a delight. It takes over the entire screen, putting up a pull-down menu bar that extends across the screen's top. You'll find, however, that the most common operations don't require you to go to the menus. Rio makes sublime use of quickly learned mouse/tablet shortcuts for the things you do most often.

If you're accustomed to working with a monochrome line-art representation and switching to a special preview mode to see colors and object stacking, Rio's real-time viewing may take some getting used to. I immediately took to it, and I found myself far more productive than with the two-step drawing tools I was used to. Performance is affected: Colored polygons take longer to appear on the screen than lines do. Rio performs reasonably well, though, and the benefit of seeing what I was drawing was worth the trade-off.

As a polygon drawing tool, Rio more than holds its own. There is no toolbox of shapes and actions. Instead, the pull-down menus use words to describe the object types and the actions available. To draw a square, you select Square from the Build menu and then drag out the square's dimensions with the mouse or pointer. To move, rotate, resize, flip, copy, or delete the square, you need only click with the mouse to select it and place the cursor inside the selection box that appears around it. As you move the cursor around the

perimeter of the selection box, the cursor changes shape to show the action that will take place if you click again.

The object-attribute dialog boxes are also quick to access. They pop up with a mouse-click for selected objects and offer control of color (including gradients), shadows, transparency, and image mapping. Selecting a color in the attribute dialog box brings up a palette. You can rotate through several default palettes or add your own entries at will. Rio supports RGB, HLS (hue, luminance, saturation), CMY (cyan, magenta, yellow), and HSV (hue, saturation, value) color models.

Gradient patterns are a special case. They can be rendered at any angle and can include up to eight color stops. Rio creates a smooth transition between the colors selected to produce the gradient.

Image mapping is one of Rio's most powerful features. A scanned or captured image—or any graphics file in one of the many supported formats—can be used as an object's foreground color. You can interactively crop and shape the image to produce all kinds of effects. Rio scales and smooths the imported image to match the shape and cropping you select. Rio will import images directly from a scanner or Truevision video card. In the latter case, Rio handles all the image-capture functions internally. A particularly nice touch is Rio's field average function; this very effectively removes motion artifacts (i.e., jitter) from captured video frames.

Rio's background can also take on a flat color, a gradient, or an image map. If you are using a Truevision video card, you also have the option of making the background "live"—that is, the video coming into the Truevision card becomes your background. With this, you can use Rio to create video-overlay graphics and titles. A scene rendered with a live background can be reloaded and displayed on top of live video, using either Rio or GSL's Panorama presentation software.

Getting a Look

While Rio shows you something very close to the finished output as you draw, it does cut a few corners for speed's sake. When you select the Render, Print to File, or Print to Device menu options, Rio renders the scene, delivering the best possible quality for the type of output device being used. With VGA, this is only as good as a 256-color palette can deliver. But with the Multimedia Lab's ATVista, Rio takes full advantage of the card's 16.7 million colors. Everything is antialiased to smooth diagonals and curves and improve the image's apparent resolution. Image maps are smoothed to hide the artifacts of scaling. Text is automatically kerned, and the completed drawing is either displayed on the screen, saved in a file, or sent to an external device, as you request. Rio will apply a number of image effects at your request, including emboss, contrast shift, negative, black and white, mosaic, posterize, and soften.

Rio's Print to File option lets you save an optimized render directly to disk in one of a number of popular graphics file formats. You can then import these files into other programs and for use as presentation slides (see the screen), backgrounds, or what-have-you.

Rio's Animator add-on attaches a powerful key-frame animation system to Rio's 2-D graphics facility. Each object's position, size, visibility, transparency, and color, as well as many other attributes, can be smoothly animated between key frames. With Rio, animation is as simple as drawing objects as you'd like them to appear at the start of the animation, setting a key frame, and then changing the objects to reflect the way you want them to look at the end of the animation. Rio will create smooth transitions between those two key frames. You can set any number of key frames, and a key can be applied to an object, a group, or the entire scene. Rio includes a sophisticated time-line editor that lets you alter the speed, direction, and other elements of your objects' animation.

You can render finished animations to videotape, consecutive image files, or animation files. Once again, Rio's animation capability is fully self-contained. It includes the ability to automatically render and record individual frames to videotape using supported VCR control devices, allowing completely unattended operation. It will also save animations, one frame at a time, to consecutively numbered image files, for spooling to video, film, or some other medium.

Finally, Rio will create Autodesk Animator–compatible FLI (low-resolution) and FLC (high-resolution) files that contain a compressed copy of all the animated frames. You can then use a player (from Autodesk or numerous other third-party sources) to quickly play back the images in sequence to reproduce the animation on your computer's display.

Return from the Islands

For the past two years, in the face of a steady parade of graphics packages, Rio has remained my hands-down favorite for 2-D graphics and animation, because I can quickly create professional-looking images. I might have written that off to familiarity, except that I was productive from the first day it arrived. Nothing I've tried since has got me through the learning curve so fast, provided so many built-in services (like video capture and animation), or produced such beautiful output on so many kinds of devices.

Rio has a quirk or two, to be sure, but they're minor. I put Rio through some positively grueling paces for this review, and I was always impressed with its performance, stability, and quality of output. Whether your medium is 35mm slides, color overhead transparencies, hard copy, or video, Rio makes it easy to create graphics that will impress your audience. ■

Tom Yager is director of the BYTE Multimedia Lab and author of the forthcoming book The Multimedia Producer's Handbook *(Academic Press). He can be reached on BIX as "tyager" or on the Internet at tyager@bytepb.byte.com.*

BYTE ACTION SUMMARY

WHAT RIO ANIMATOR IS
A professional 2-D presentation graphics tool with key-frame animation.

LIKES
Quick access to common operations; complex gradients; image mapping; internal support for input and output devices; stunning results.

DISLIKES
Too high-priced; fixed viewpoint for animation (no movable "camera").

RECOMMENDATIONS
This is a fast, easy-to-learn presentation graphics system geared toward professional-quality output; I recommend it very highly as a step up from traditional PC presentation graphics programs.

PRICE
$1795; Animator option, $1495

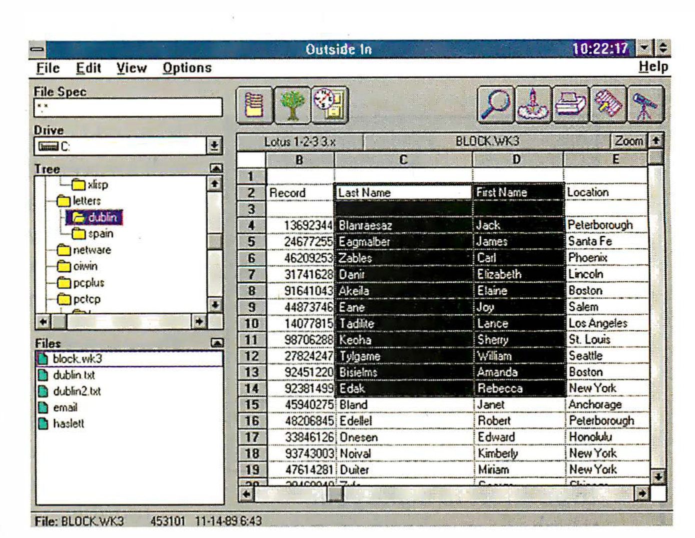
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Indianapolis, IN 46240
(317) 844-4364
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APPLICATION

Bringing the Outside into Windows

STEVE APIKI

Outside In for Windows is a document utility that aims to make it easier for those of us who live inside Windows to work with documents generated by those in the outside world. Outside In lets you view documents, complete with formatting (e.g., tabs and spacing), from DOS and Macintosh applications. Outside In blends viewing capability with cut-and-paste data transfer, printing, and file-finding and navigation tools to create a working environment that's ideal for handling multiple document types.



Outside In's viewer lets you copy and paste between DOS document formats (in this case, a file from Lotus 1-2-3) and Windows applications. You can also search for files by document type and content and print formatted documents.

Viewing Documents

File viewing is the central task of Outside In for Windows. Loading a document into the viewer requires only double-clicking on the filename in one of the navigation boxes or hitting the magnifying-glass button with the proper file highlighted (see the screen). Outside In displays the file complete with font styles, margins, and other formatting features.

Outside In handles a raft of file formats. There are too many to enumerate here, but Outside In covers just about every popular word processor designed for DOS, Windows, and the Mac, and most DOS spreadsheets and databases. I ran Outside In with documents from several versions of Lotus 1-2-3, Quattro and Quattro Pro, FoxPro, Microsoft Word (DOS, Mac, and Windows versions), WordPerfect, XyWrite, and Ami Pro. The viewer worked flawlessly most of the time, but I had some problems with two 1-2-3 documents (Outside In reported that the documents were empty when they weren't). Systems Compatibility was working on a fix as we went to press.

Don't Just Watch

Outside In for Windows is more than a viewer; in fact, its most useful capability is its transferring of formatted data between DOS and Windows applications through simple cutting and pasting. To transfer data between, say, a Quattro spreadsheet and Ami Pro, you load the spreadsheet into the viewer, select the part you need, copy your selection to the Clipboard, and paste it into Ami Pro.

This mechanism makes it extremely easy to combine information from various formats. Outside In defaults to placing the data on the Clipboard in every format that it supports (i.e., Text, Rich Text Format, and several Windows applications), but you can customize the copy operation to choose only formats you select.

Outside In's integration with these and other elements of Windows is very solid. It installs itself as a menu item in the Windows File Manager, allowing you to launch the utility directly from the File Manager menu. You can also drag and drop documents between the 3.1 File Manager and Outside In. Finally, Outside In will replace the file viewers in Norton Desktop.

Navigation and search tools make Outside In for Windows a full working environment. You can search for documents based on type, location, or even by contents. The navigation window is generally well designed, but it lacks a collapsible hierarchy; with a complex directory structure like the one on my disk, you can easily lose yourself in directories nested several levels deep.

Overall, Outside In for Windows is an outstanding tool if you need to work in a shop where many document formats are common. One of Windows' strongest selling points is that it provides a consistent mechanism for opening and printing documents and for transferring data between applications; Outside In extends this environment to include documents born outside of Windows. ■

Steve Apiki is a BYTE technical editor with a B.S.E.E. from Rensselaer Polytechnic Institute. You can reach him on BIX as "apiki."

BYTE ACTION SUMMARY

■ **WHAT OUTSIDE IN FOR WINDOWS DOES**
It lets you view documents from DOS applications within Windows and lets you copy and paste between those documents and Windows applications.

■ **LIKES**
Easy cutting and pasting between DOS and Windows applications; wide variety of file formats.

■ **DISLIKES**
Errors with supported document types; directory tools are lacking.

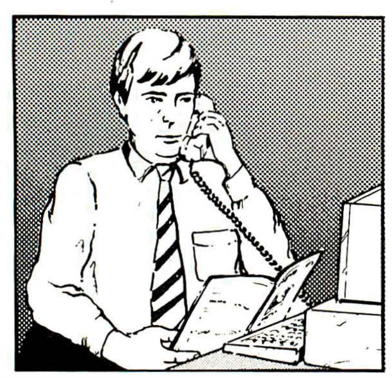
■ **RECOMMENDATIONS**
If you work in Windows but need access to other documents, Outside In is outstanding.

■ **PRICE**
$89

■ **FOR MORE INFORMATION**
Systems Compatibility Corp.
401 North Wabash, Suite 600
Chicago, IL 60611
(800) 333-1395
(312) 329-0700
fax: (312) 670-0820
Circle 1231 on Inquiry Card.

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SOFTWARE

A/UX 3.0: The Mac's Odd Couple

TOM THOMPSON

What could be stranger than the Mac OS, renowned for its friendly user interface, working in tandem with Unix, whose user-hostile attitude is legendary? Nevertheless, that's exactly what Apple's implementation of Unix—known as A/UX—accomplishes.

A/UX allows the Mac OS and applications to operate on the traditional Mac Desktop beside Unix programs and tools running in console windows. A/UX 2.0 managed this Jekyll-and-Hyde duality decently (see "A Workstation in a Mac's Clothing," January 1991 BYTE). It combined features from both AT&T System V release 2 and BSD 4.2 Unix, and it used System 6.0's MultiFinder to run Mac applications. However, some Unix tools were missing or out of date, support of third-party peripherals was spotty, and not all Mac OS facilities were available. The latest release, A/UX 3.0, eliminates many of these shortcomings.

A/UX 3.0 uses System 7.0 for Mac application support. This is crucial for providing access to the high-powered Mac Quadras, which require System 7.0 to operate. Most Mac OS facilities, including the Sound Manager, multiple monitors, and even the QuickTime multimedia facilities, are supported. A/UX still uses AT&T System V release 2 version 2 (the latest release is SVR4), but the BSD portions are the up-to-date 4.3 version. Supplied with A/UX 3.0 is a boatload of network, text-processing, and development tools. A/UX 3.0 also supports Apple's SCSI scanners and some third-party hard drives, tape units, and CD-ROM drives.

Improved Installation

These enhancements have upped the hardware requirements for A/UX: You need an FPU (Mac IIsi users, take note), a minimum of 8 MB of RAM, and an 80-MB hard drive, although a 160-MB drive is preferable. The software comes either preinstalled on a Mac or on a CD-ROM.

Installation from the CD-ROM now requires only the CD-ROM itself and one floppy disk. You start the Mac and insert the installation disk and the CD-ROM in their respective drives. After several minutes, the disk ejects and code execution transfers to the CD-ROM, which functions as a slow hard drive. The A/UX installation application closely resembles the Mac OS software Installer application. You can install all or a subset of the software.

The CD-ROM comes packed with core Unix software; development tools such as an assembler and C and ANSI FORTRAN compilers; source-control utilities; X Window System support (both MacX and X11 2.1.1), and X development tools. There's also a grab bag of networking software: NFS (Network File System) 4.1 for file sharing, UUCP (AT&T V.4 version), CSL/IP, and TCP/IP utilities. Once you've made your selections, you let the CD-ROM and computer chug away for a while, and you're done. On a Mac Quadra 950 with a 160-MB hard drive, the complete A/UX software installation took an hour and 15 minutes, and it occupied 72 MB on the hard drive.

Prior to A/UX 3.0, those using third-party hard drives had to hope the vendor's software could create the Unix partitions required by A/UX. In a great show of faith by Apple, its HD SC Setup 3.0 application, which formats and partitions Apple hard drives for A/UX, now recognizes and works with third-party hard drives.

Setup and Performance

I tried A/UX 3.0 on two systems. One was a Mac IIci equipped with an 80-MB hard drive, 8 MB of RAM, a SuperMac 17-inch monitor with a Spectrum/8•24 PDQ display board, and a SuperMac 19-inch monitor with a Thunder/24 display board. The other was a Mac Quadra 950 with 8 MB of RAM, a 160-MB hard drive, and a Mac 16-inch monitor that used the Quadra's built-in video. To eliminate the storage-space problem on the IIci, I successfully installed and ran A/UX 3.0 on a Storage Dimensions 1-GB hard drive using only the A/UX installation software.

The IIci was connected to the BYTE network via an Apple Ethernet NB board. At first, I couldn't get the Ethernet services to work, although the LocalTalk services worked fine. I had to locate an oblique reference on the A/UX Read Me floppy disk and scan several manuals before I deduced that I had to install an Ethernet software module using `newconfig`. After `newconfig` modified the A/UX kernel, the Ethernet board began operating. I'd recommend that the first thing you do when you get A/UX up and running is print out the on-line manual pages for `newconfig`, because many of the network services (e.g., NFS, TCP/IP, and CSL/IP) have to be added through this program.

With contact to BYTE's Ethernet network established, I used `ftp` to copy the BYTE Unix benchmarks to both computers for performance testing. As you can see in the table, the 33-MHz 68040-based Quadra 950 weighs in with an average index of 2.5, making it more than twice as fast as a Sun Sparcstation IPC. The Mac

BYTE ACTION SUMMARY

WHAT A/UX IS
A combination of AT&T System V and BSD Unix that allows Mac applications to run concurrently.

LIKES
It offers access to Mac applications for graphics and imaging, point-and-click network and virtual memory control, and lots of Unix utilities.

DISLIKES
It still needs work on documenting Unix kernel configuration.

RECOMMENDATIONS
A/UX is valuable for Mac users who need ready access to Unix and for Unix wizards who need ready access to quality graphics or imaging applications.

PRICE
CD-ROM, $709
CD-ROM and AppleCD 150 CD-ROM drive, $1208
Upgrade from A/UX 2.0, $245

FOR MORE INFORMATION
Apple Computer, Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
Circle 1313 on Inquiry Card.

BYTE LAB BENCHMARKS

A/UX running on a Quadra 950 makes it more than twice as fast as a Sun Sparcstation IPC. For each index, a Sparcstation IPC = 1.

Test	Baseline	Result	Index
Arithmetic (type = double)	2541.7	2743.3	1.1
Dhrystone 2 (without register variables)	22,366.3	21,533.3	1.0
Execl Throughput	16.5	157.5	9.5
File Copy Throughput (30 seconds)	179.0	315.0	1.8
Pipe-Based Context Switching	1318.5	957.1	0.7
Shell Scripts (eight concurrent)	4.0	3.0	0.8
Sum of six items			14.8
Average			2.5

IIci results (not shown in the table) give A/UX 3.0 an index of 1. The A/UX 2.0 review summed up the situation, still true today: Compared to new Unix workstations, the Quadra is neither a barnburner nor a lumbering cow in performance.

On the Mac side, System 7.0 features such as File Sharing and TrueType worked, as did all the Mac applications. I could move scanned images displayed by Adobe Photoshop from one monitor to another on the Mac IIci without problems. When copied to the `/mac/system/System Folder`, Control Panels and Extensions such as Now Utilities' Super Boomerang 3.0.2, Adobe's Type Manager 2.0.3, and Rock Ridge's VideoBeep 1.02 (a QuickTime player) ran flawlessly. This came as no surprise, since most Mac applications and utilities are System 7.0 compatible, which automatically makes them compliant with A/UX.

A Real Improvement

How does a Mac running A/UX stack up against other workstations? A Quadra 950 with 8 MB of RAM, a 230-MB hard drive, a 16-inch Apple monitor, and a keyboard costs about $10,300. This appears a tad pricey compared to some workstations, but the Mac brings important features to the Unix party. First, the Quadra's price includes 24-bit color. Second, to expand your view, you just add another display board and monitor. If you do huge layouts or extensive CAD work, the ability to span two or more monitors is a big win.

Finally, A/UX gives Unix wizards access to a raft of Mac desktop publishing, color prepress, image-editing, and multimedia applications. A/UX 3.0 is an improvement worth looking into. ■

Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. from Memphis State University. He is also an associate Apple developer. You can contact him on BIX as "tom_thompson" or on AppleLink as "T.THOMPSON."

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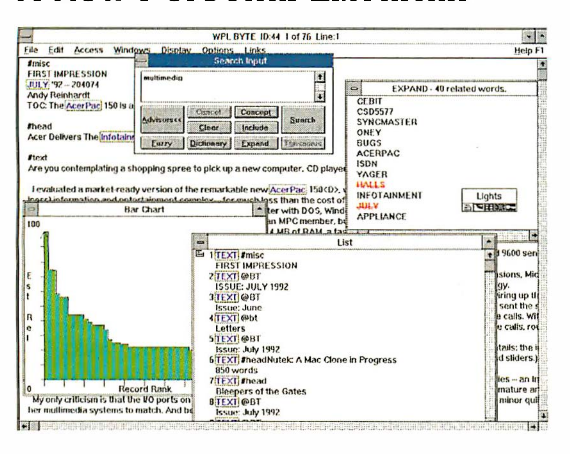
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A New Personal Librarian



The result of a Windows Personal Librarian concept search on the term multimedia *shows related terms, a list of documents, a bar graph outlining the relevancy of each hit, and the highest-ranking document.*

Personal Librarian, one of the most powerful text managers on the market, was in the midst of a major upgrade as we wrote June's Solutions Focus on text management. Here is a quick review of the new Windows Personal Librarian 3.0.

Personal Librarian indexes files on your hard disk, leaving those files in place and storing only index and related database information. The latest version supports WordPerfect and Word for Windows files as well as text.

You can use Personal Librarian as a stand-alone document retrieval system, but the package is clearly designed for network operation. The user module allows you to search indexes and view documents, while the administration unit lets you add and remove files, create hypertext links, and perform other maintenance.

Personal Librarian supports the usual repertoire of Boolean search expressions and fuzzy searches, but its *concept search* capability is by far its most powerful feature. Concept searching is not the typical grouping of related search clauses found in other packages: Instead, the Personal Librarian program builds a concept from a single search expression by finding related words on its own.

For example, you might search an index of BYTE for the term *multimedia*, but you'd miss documents you might want to find on CD players and the like if those documents didn't contain the term itself. If you run a concept search on *multimedia*, however, Personal Librarian first expands the search list by searching through its index for related words. Then it searches for those related words in each document (see the screen). Naturally, this generates a lot of hits for each search, but Personal Librarian uses a proprietary relevancy-ranking algorithm to determine which documents most closely match your request.

Personal Librarian searches almost instantaneously and indexes very quickly: We added 3 MB of BYTE article data to an index in under 15 minutes on a fast 486. But for most people, the power of Personal Librarian's concept searching will provide the strongest draw. If you have complex text documents where the proper search term isn't always obvious, Personal Librarian is the way to go.

Good but Not GreatWorks

Before we could do a review of GreatWorks 1.0, Symantec brought out a new version of its integrated software program for the Mac. This package gives you a word processor, database, spreadsheet, chartmaker, drawing program, painting program, outliner, and telecommunications program all in one box. Additions include 50 new features, the ability to paint in color, and support for System 7.0 features like Publish/Subscribe. While you can easily bring, say, a pie chart into a word processing document by cutting and pasting, Publish/Subscribe maintains hot links between such elements. So, if you make a change to the original pie chart or graphic or worksheet, or whatever, the version embedded in the word processing document is automatically updated.

Handy as this can be, there's one problem with the implementation of Publish/Subscribe. GreatWorks doesn't just make the change in the object you've put into the document; it replaces the object with a copy of the revised version. Much of the time, this is not a problem. But say you've drawn something with the drawing or painting modules, placed that graphic in a text document, and then scaled it down to fit into a particular space. The changed drawing comes in at the size of the original, so you then have to go into the word processing module and resize the graphic again to make it fit.

The applications themselves do a good job handling typical chores. You can't assemble a fancy newsletter with the word processor, the spreadsheet doesn't do autosumming, and the communications package will perform only XMODEM and text transfers. But for most run-of-the-mill operations, these modules are more than sufficient. More significant for some users, the whole kit and caboodle takes up only 2.5 MB of hard disk space and will run in 1 MB of RAM. GreatWorks 2.0 certainly likes more memory than that, though.

While each of the modules can stand on its own as a competent application, the integration of these modules could be more elegant. Sharing data between them is simple enough, but going from module to module could be a little easier. It would be great if you could, for example, click on a chart in a document and have the charting program fire up.

Regardless of our few quibbles with implementation, GreatWorks 2.0 is a mighty fine bargain. Eight capable programs for $299 is a real deal. ■

—The BYTE Lab

Reviewer's Notebook provides new information—including version updates, new test data, and long-term usage reports—on products and product categories.

ITEMS DISCUSSED

Windows Personal Librarian 3.0
(stand-alone version)..................$995
Personal Library Software
2400 Research Blvd., Suite 350
Rockville, MD 20850
(301) 990-1155
fax: (301) 963-9738
Circle 1076 on Inquiry Card.

GreatWorks 2.0........................$299
Symantec Corp.
10201 Torre Ave.
Cupertino, CA 95014
(408) 253-9600
fax: (408) 252-4694
Circle 1077 on Inquiry Card.

BOOK
AND CD-ROM REVIEWS

HUGH KENNER



THE ORIGINS OF HYPERTEXT

From Memex to Hypertext: Vannevar Bush and the Mind's Machine
James M. Nyce and Paul Kahn, eds.
Academic Press, 1992, $39.95,
ISBN 0-12-523270-5

Vannevar Bush—does that name ring, perhaps, a faint bell in your mind? A nearby dictionary says "1890–1974; U.S. electrical engineer & administrator."

"Administrator," indeed; how fame does fade! During World War II he was head of the Office of Scientific Research and Development—U.S. Science Czar—and one of many claimants to A-bomb fatherhood. He'd been a dean and vice president at MIT; later he headed the Carnegie Institution.

And "electrical engineer" is a futile stab. Bush was a computing pioneer at a time, 60 years ago, when it still wasn't clear (except to Alan Turing) whether the useful future was analog or digital. I don't know if Bush ever heard of Turing, who by the 1930s had proved that all digital computers are essentially the same computer: versions of what we now call the Turing machine.

But while Turing started from logic, Bush started from problems, such as how to get the data for contour lines on maps (normally, "several men, careful fieldwork, and tedious data reduction afterwards"). It occurred to Bush that if you pushed a wheeled box over hilly ground, gears inside the box could record changes in elevation. His profile tracer got him a patent and a master's degree (Tufts University, 1912).

The idea, you see, was to have gears act out the problem. That's analog thinking. Later, differential equations helped generalize it, and by 1942 the differential analyzer—gears plus relays, motors, and vacuum tubes—on which Bush had spent nearly two decades was helping win the war. But by 1950 its upkeep was merely "a burden on MIT." That anticlimax reflects the dawn of digital.

Something else that occupied Bush from at least 1932 was how on earth we'd ever find anything amid the sheer proliferation of print. As long ago as 1866, Mendel's crucial paper on genetics had vanished unread into "the literature," not to emerge for decades. A library should be a memory machine. So how does human memory work?

Well, it works by blazing trails of association between details that catch our fancy. Never mind those authorized headings: author, title, subject. Again, analog to the rescue! For decades, Bush described and redescribed Memex, your own personal associative memory machine that lets you tag microfilm frames you want linked. Thus, you form "an associative trail through the material...closely analogous to the trails formed in the cells of the brain."

Hypertext, you're thinking? Yes, more or less. Memex would have been desk-size and clumsy, space and speed alike dictated by microfilm's constraints. Hypertext emerged from a digital revolution that Bush seemed to feel was too abstract for comfort.

In 1945 he published his seminal Memex essay "As We May Think," both in the *Atlantic Monthly* and (somewhat condensed) in the old *Life*, with its multimillion circulation. *From Memex to Hypertext: Vannevar Bush and the Mind's Machine*, edited by James M. Nyce and Paul Kahn, now offers all the pertinent Bush writings plus pertinent commentary, not omitting a lively 1989 lecture by Norman Meyrowitz: "Hypertext—Does It Reduce Cholesterol Too?"

No one mentions a prime glitch in the analogy that underlies Memex, those paired tags for linking. Some paragraphs above, you saw Alan Turing pop into my head as I pondered Bush's fixation on analogs. I now have, yes, a link between Turing and Bush. But what did today's reading of Bush really link back to? Not to any tag I'd placed in my Turing trail in 1965, long before analog versus digital had meaning for me, and certainly long prior to any notion that I'd some day want a link from Vannevar Bush. By what process, then, did I fish up Turing this morning? By no process Memex ever thought to mimic. ■

Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. His recent books include Mazes *and* Historical Fictions. *You can contact him on BIX as "hkenner."*

UNIX FOR THE UNINITIATED

Unix has changed during the past few years; it's no longer just a language of cryptic commands and arcane syntax. Yes, those "features" are still there, but they have been complemented by sophisticated windowing GUIs that can run Unix versions of Lotus 1-2-3 and WordPerfect or even DOS software. With these and other changes has come a need for new Unix documentation and "how-to" books.

As intuitive as some of the new Unix GUIs are, however, much of the real power and usefulness of Unix come from understanding concepts like redirection and pipes and from using commands like `sed`, `grep`, and `awk`. I perused four books that all offer good descriptions of the essential Unix commands. All four emphasize AT&T Unix System V release 4.0. They also deal with networking issues and with accessing and exchanging information from remote computers with programs like `ftp`, `telnet`, and `mail`. Beyond coverage of the most common Unix commands and programs, the contents of the books vary considerably.

Unix for the Impatient appears to target readers who are comfortable with somewhat terse technical material. It presents its subject matter concisely, rather than in a tutorial manner. It covers both Unix SVR4 and BSD 4.3. This book has the most detailed descriptions of the various Unix editors and has the best presentation of the `emacs` editor. *Unix for the Impatient* is written for the person who is computer-knowledgeable and doesn't need much hand-holding. This book is the only one of the four to describe using Unix with

an X Window System GUI. It, along with *The Waite Group's Unix System V Primer*, includes an index-like listing of all the common Unix commands with short descriptions and, more important, a page reference of where a command is discussed in detail in the book.

Introduction to Unix is the one most like traditional Unix texts. It groups many common Unix commands and presents relatively abbreviated examples of their use. It would be a good book to use in conjunction with a more tutorial-type book. Although the book lacks the lengthier descriptions of `emacs` and `vi` found in the other three books, it is the only one of the four to include a detailed discussion of Unix system administration and details of the basic structure of the Unix operating system.

Unix Step-by-Step introduces you to this operating system as its title states. The book's tutorial-style approach includes a summary, review questions and answers, and exercises at the end of each chapter. It has detailed descriptions of how to write Bourne, C, and Korn shell scripts.

The Waite Group's Unix System V Primer also uses a tutorial approach with review questions and answers and exercises at the end of each chapter. The book makes good use of contrasting blue-type and blue-background sidebars to highlight important topics and examples. It also makes more effective use of graphics than the other books. The authors' easygoing style makes the reading pleasurable, and Bob Johnson's cartoons add some light entertainment and serve to introduce you to "Unix humor." The book has a particularly complete coverage of the `vi` editor.

Because the approach used in *Unix for the Impatient* fits my learning style, I found it suited me best. The concise style lets its authors cover more subject matter than the others without sacrificing clarity or assuming too much from the reader. This book also seems to have the best balance between the "old" and "new" aspects of Unix. It covers traditional Unix material like the file system structure and setting up a terminal as well as using the X interface and applications.

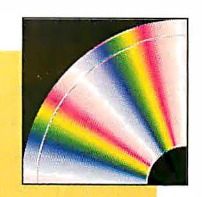
If you are more comfortable with a book that uses a tutorial approach, *The Waite Group's Unix System V Primer* is my recommendation. I give it a slight edge over *Unix Step-by-Step* for its easy-to-read layout and use of color and graphics to highlight important concepts. Many times, the best way to learn operating-system syntax is to find a specific example that is close to what you need to do and make slight revisions until you finally get it correct. This book provides ample examples of using Unix commands with their various options.

—John Unger

Unix for the Impatient, Paul W. Abrahams and Bruce R. Larson, Addison-Wesley, 1992, $26.95, ISBN 0-201-55703-7.
Introduction to Unix, Mark Schulman, Que, 1992, $24.95, ISBN 0-88022-745-1.
Unix Step-by-Step, Ben Smith, Howard W. Sams, 1990, $29.95, ISBN 0-672-48469-2.
The Waite Group's Unix System V Primer, 2nd ed., Mitchell Waite, Don Martin, and Stephen Prata, Howard W. Sams, 1992, $29.95, ISBN 0-672-30194-6.

John Unger is a scientist who works for the U.S. government in the Washington, D.C., area. He can be reached on BIX as "junger."

ROAD MAPS ON CD-ROM



Street Atlas USA, $169 from DeLorme Mapping (Main Street, P.O. Box 298, Freeport, ME 04032, (207) 865-1234; fax (207) 865-9628).

Street Atlas USA, DeLorme Mapping's CD-ROM for Windows, contains over 1 million maps of U.S. streets. It installs directly from the CD-ROM drive. The program has the familiar look and feel of a Windows application, but it has no pull-down menus. All functions are accessible through push-button icons on the right side of the screen. The main screen displays the active map. When you start up Street Atlas USA, the main area displays a color map of the U.S. When you draw a box on this map using the mouse, you zoom in on your selected area. You scroll around the map by clicking on different compass points. To move faster, you simply slide a selection box across a thumbnail map at the bottom of the icon palette.

One click on a push button triggers rapid searches using the criteria you select. For example, enter ZIP code 30319, and you'll see a detailed map of northeast Atlanta. Type in area code 603, exchange 673, and up pops a map of Milford, New Hampshire. Or you can enter any state or town name in the U.S. to pull up a local map. From there, you search for the specific street name you want. The software then displays its location, highlighting the street on the map. At any magnification level, you can continue to scroll about using the compass controls. Push buttons let you zoom in or out at any time and copy the active map to the Windows Clipboard. The interface is fast, well designed, and efficient.

What's truly impressive is the detail of the maps. DeLorme started with the Census Bureau's TIGER (Topologically Integrated Geographic Encoding and Reference) maps and embellished them with other contracted and in-house data sources.

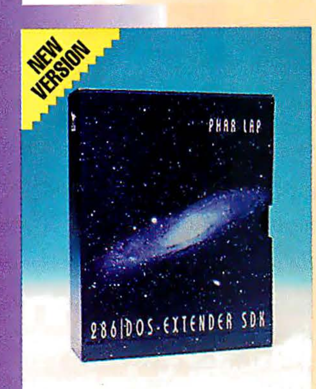
BYTE editors searched out old haunts, from Kailua, Hawaii, to Kasilof, Alaska. Some road names were missing from the truly backwater spots, but we found it hard to stump the program with an unknown street reference. The current maps are two years old, but DeLorme plans to update the disc annually.

If you're always getting lost, buy DeLorme's GPS MapKit. You get a CD-ROM drive, mapping software, device driver software, and an antenna and receiver to link to the Global Positioning Satellite System, a network of 24 orbiting government satellites. The GPS package lets you keep a constantly updated display of your current location on the electronic map. Hook it up to a notebook computer in your car, and tour the country with confidence. All you need is money—$10,000 versus $169 for the CD-ROM alone. But you may never take a wrong turn again.

—Stanford Diehl



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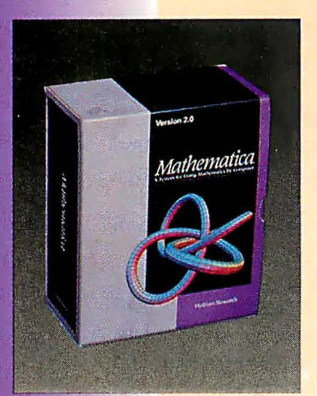
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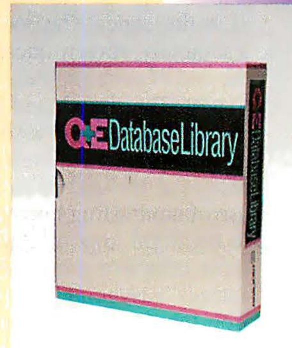
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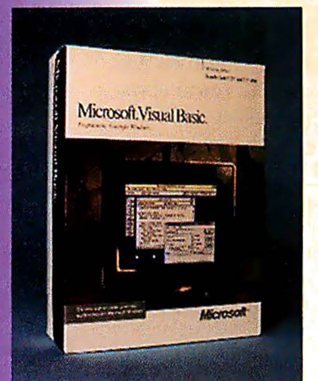
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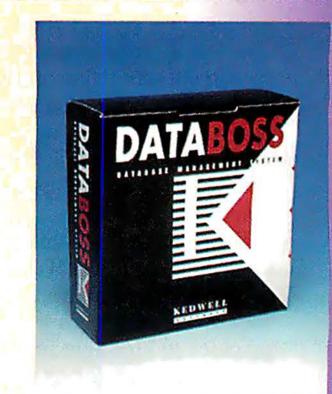
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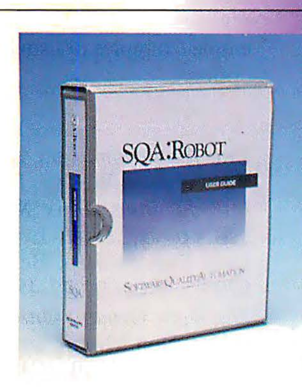
Distinct TCP/IP for Windows SDK extends the TCP/IP and RPC/XDR networking capabilities to Microsoft Windows. Includes the smallest and fastest DLLs today available for Berkeley Sockets, RPC, Telnet, and FTP. Coexists on the same board with Lan Manager, Novell and Banyan. Supports Packets, NDIS and ODI drivers. Only 5KB of DOS memory required.

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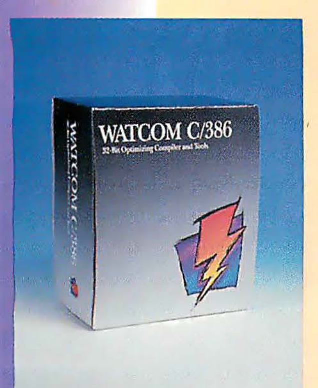
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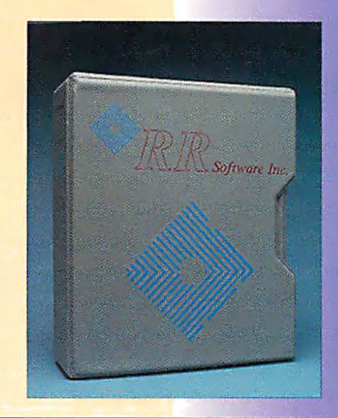
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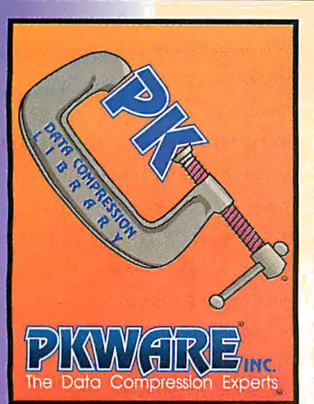
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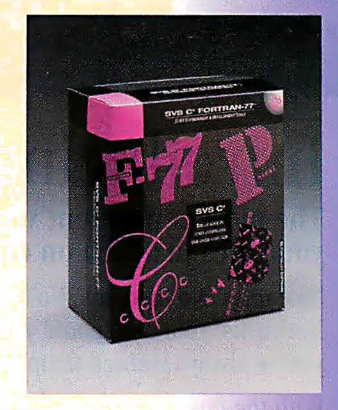


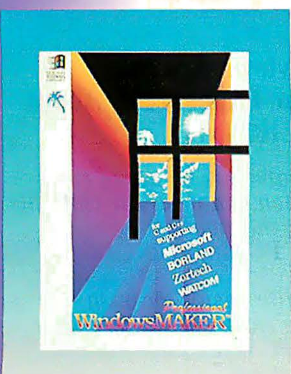
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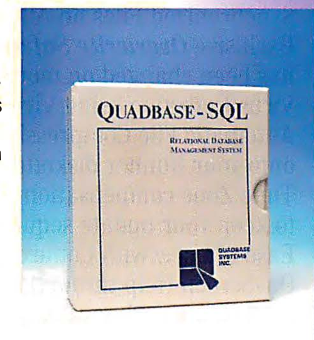
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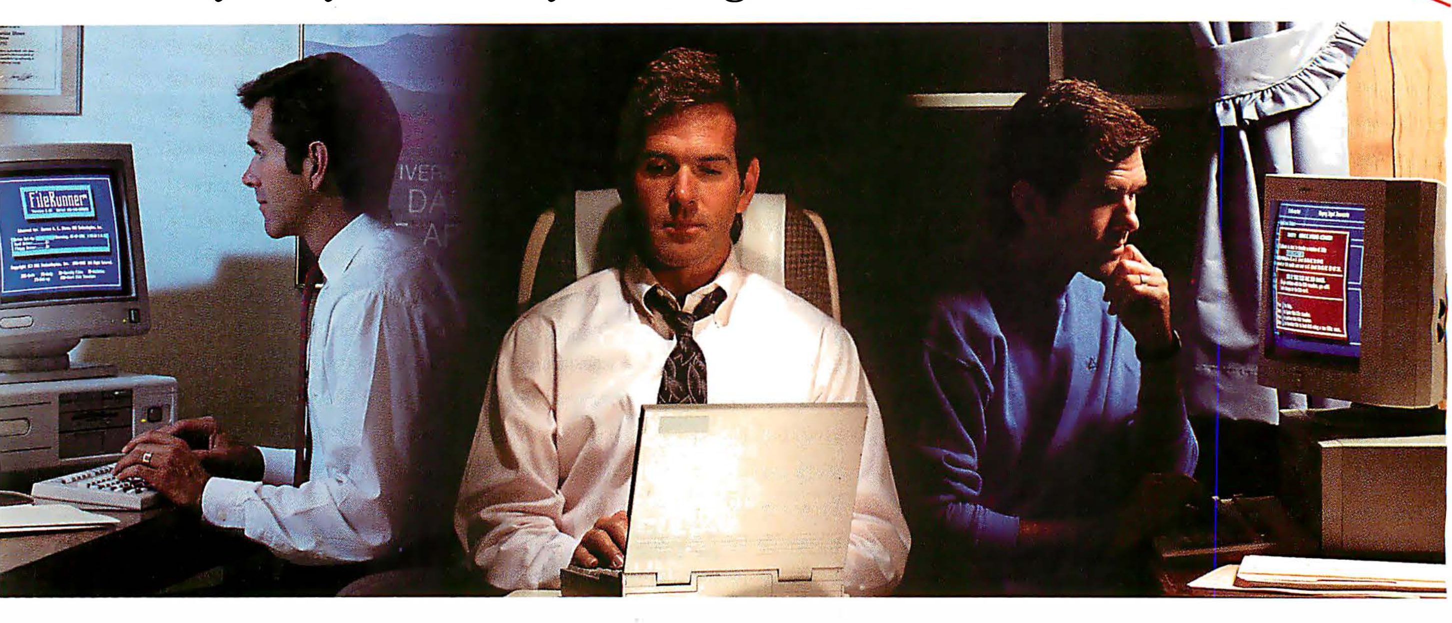


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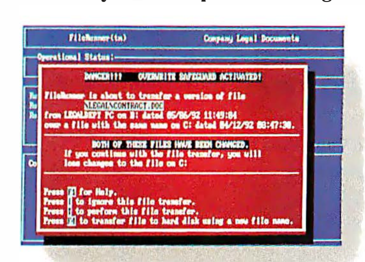
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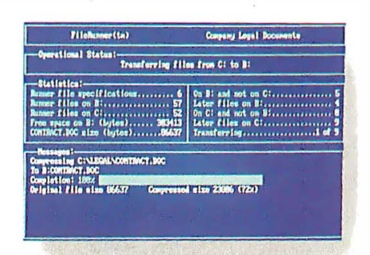
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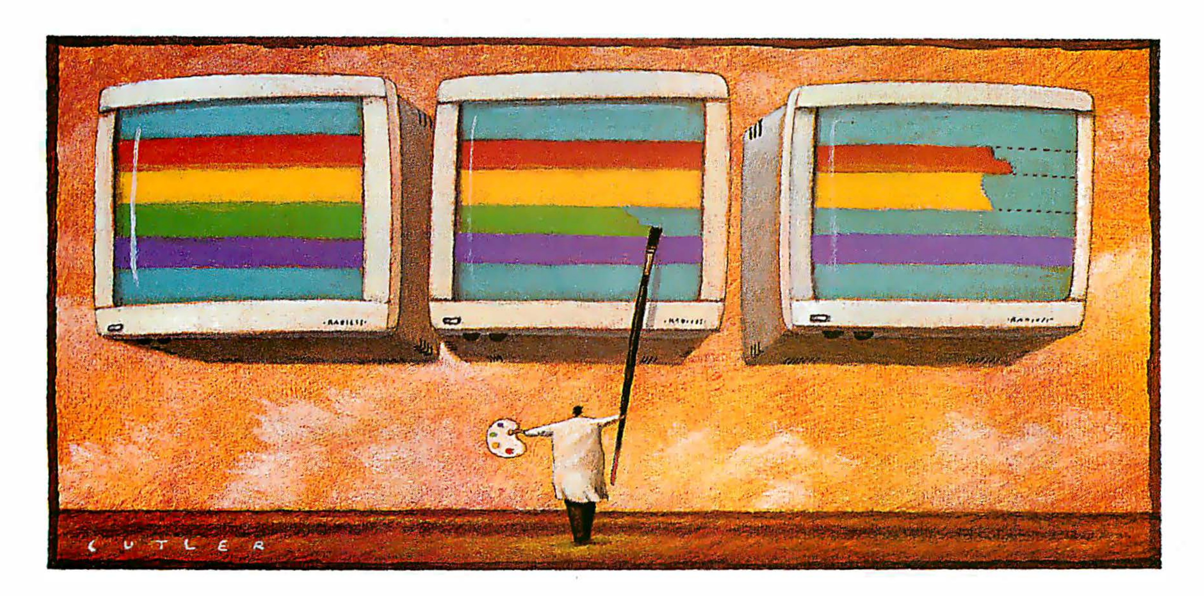
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INSIDE QUICKDRAW



Here's how the Macintosh's graphics engine operates to produce optimum visual results, regardless of the display's limitations

One of the Macintosh's most renowned features is its graphics. This capability is provided by a powerful yet flexible graphics engine known as QuickDraw. QuickDraw is built into every Mac's firmware and is responsible for everything that appears on the Mac's screen, whether it's the Mac's own GUI, a newsletter page in a desktop publishing application, or a 24-bit-color scanned picture in an image-editing application.

To handle this broad range of graphics operations, QuickDraw provides a rich set of drawing and imaging functions for the programmer's use. These graphics functions add a layer of abstraction between the drawing that an application performs and what appears on the screen.

What does that last sentence mean? Put another way, QuickDraw resolves an application's drawing commands into actions that affect the frame buffer and display hardware of the Mac on which the application runs. QuickDraw accomplishes these drawing operations effectively, regardless of the output device's dimensions and pixel depth. I use the term *device* here because QuickDraw can be used to draw to printers and film recorders as well as monitors.

Because QuickDraw manages every aspect of the Mac's display, you shouldn't bypass QuickDraw to draw something on the screen. If you somehow directly jam graphics data into a Mac's frame buffer, two things will happen—both of them bad. First, another application using QuickDraw will stomp on your drawing. Because you didn't use QuickDraw, QuickDraw doesn't know you put something on-screen, so it freely draws over your portion of the screen. Second, this ties your application to one specific set of hardware, which might not be compatible with different combinations of existing hardware, and certainly not with future hardware.

Another, less touted feature of QuickDraw can be found on modular Macs with NuBus slots: You can easily expand your screen real estate by adding another monitor and display board. You can create a Desktop that consists of up to six different displays of varying sizes and pixel depths this way, and all Mac applications automatically make use of all the screens.

Having multiple monitors is extremely useful for working with several applications at once. Another benefit of such a setup is that you can configure each monitor for the operations that take place on it. When I write articles that use color artwork (like this one), I set the monitor on which I'm constructing the art to use 32-bit color and the monitor on which I'm writing the text to use 1-bit black and white. This allows me to see my artwork in full color while editing the text at top speed, because 1-bit black-and-white graphics (which includes text) are

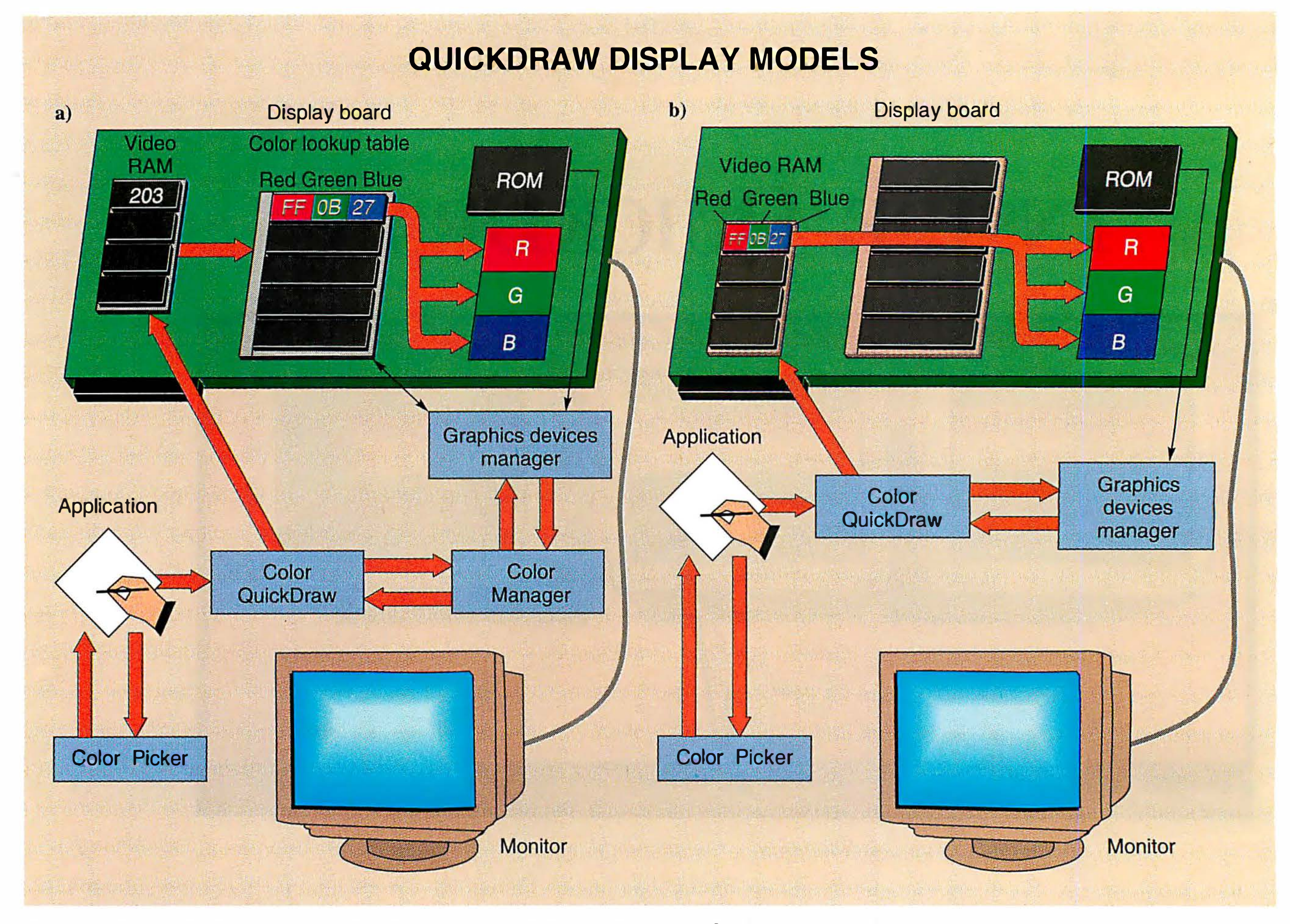


Figure 1: *The QuickDraw models for displaying* **(a)** *indexed pixels and* **(b)** *direct pixels. In the indexed model, each pixel contains a value that is an index into a color table on the display hardware. In the direct model, each pixel contains the actual color information used by the display hardware.*

significantly faster than those that are in 32-bit color.

QuickDraw Basics

How does all this work? Low-level parts of the Mac OS provide QuickDraw with the address of the target device's frame buffer. Again, the target device might be a printer or a piece of imaging hardware other than a monitor. For NuBus boards, low-level routines that are part of the Slot Manager obtain the display board's frame-buffer address, image dimensions, and pixel depth. The Slot Manager also loads the driver that QuickDraw uses to control the board's hardware. (For more information, see "Macintosh Video Revealed," April 1991 BYTE.) QuickDraw uses this gathered information to render the best possible graphics on the given Mac display.

Through QuickDraw and the Window Manager, an application works in the local coordinates of a rectangular drawing area called a `GrafPort` (i.e., the window). The `GrafPort` contains state information about how QuickDraw should perform drawing in that window. With the `GrafPort` state information in hand, QuickDraw can manage the accurate presentation of a window that straddles two monitors of different pixel depths.

QuickDraw can draw two basic kinds of objects: *geometric objects*, such as lines, rectangles, and text; and *pixel images*, which are arrays of color pixels termed a *pixel map* (as opposed to a black-and-white bit map). These two objects get their color information from different sources.

When a geometric object is drawn, its color is stored in the `GrafPort` as a 48-bit RGB value (16 bits for each of the three color components—red, green, and blue). Given the color, location, and geometry of an object, QuickDraw renders the object on each physical device the object intersects. Since individual devices have varying color capabilities, QuickDraw must determine how best to represent the source (48-bit RGB data) on each device. How QuickDraw performs this color mapping is explained below.

A pixel map (or pixmap for short) is a 2-D grid with a color value at each integer grid point; the color information is stored within the pixmap itself. Pixmaps can be scanned images, or they can represent the image that appears on the Mac's monitor(s). Currently, QuickDraw supports pixmaps that are 1, 2, 4, 8, 16, and 32 bits deep.

Pixmaps can be the source of a drawing operation, as when a scanning application takes 32-bit-color image data and places it into a pixmap in memory. Pixmaps can also be the destination of a drawing operation, as when the same scanning application takes the 32-bit-deep pixel image and draws it onto an 8-bit-deep Mac screen. Thus, QuickDraw must be able to map colors from source depths of 1, 2, 4, 8, 16, and 32 bits per pixel (for pixmaps) and 48 bits per pixel (for geometric objects) to destination depths of 1, 2, 4, 8, 16, and 32 bits per pixel.

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How QuickDraw Maps Colors

To understand how QuickDraw actually maps colors, first consider the two color models QuickDraw uses: *indexed* and *direct*.

Indexed color (1, 2, 4, or 8 bits) is limited to displaying one, four, 16, or 256 colors simultaneously, but the accuracy, or resolution, of each of those colors is very high (48 bits, even though most hardware is capable of reproducing only about 10 to 12 bits per color component accurately). In the indexed color model, each pixel's value in the pixmap represents an index into a color table. The entries in the color table contain the actual digital values the display hardware uses to present the color (see figure 1). Although the depth of the pixmap is only 1, 2, 4, or 8 bits, the resolution of the color information as provided by the color table is 48 bits.

The direct color model is fundamentally different. Direct pixmaps store the digital values in each image pixel rather than in a color table. The advantage of the direct model is that it can accommodate larger pixel values than the indexed color model, so many more colors can be displayed simultaneously. Direct pixmaps are generally easier to manipulate, since they remove the overhead required by color-table searches. The disadvantages of the direct color model are that the larger pixels require much more memory to store an image, image manipulation is slower because there is more color data to work with, and pixels are accurate to only 8 bits per color component (but this is plenty for most applications).

Thus, a source pixmap has three levels of resolution: 16 or 32 bits (direct) or 48 bits (indexed). However, life gets interesting when a source pixmap must be drawn to a destination device such as a display board. When the destination is a direct pixmap, mapping colors is easy. If the destination's pixel depth is smaller than the depth of the source, the low bits are thrown away so the color values are truncated to the size of the destination. When the source's depth is smaller than the destination, the pixel's color-table value (not its index) is copied into the destination pixmap. A special case occurs when the source is a direct pixmap that's 16 bits deep and the destination is 32 bits deep. Here, the 5 high bits of the source are taken as the top 5 bits of the destination, and the top 3 bits of the source are taken for the bottom 3 bits of the destination.

When an indexed pixmap is used as the destination, the color mapping process becomes more complicated, since QuickDraw must find the index of the closest color in the color table. Rather than search the color table each time an index is needed, QuickDraw builds a structure called an *inverse table*. It's commonly called an inverse color table since it maps a color to an index, rather than an index to a color as a standard color table does.

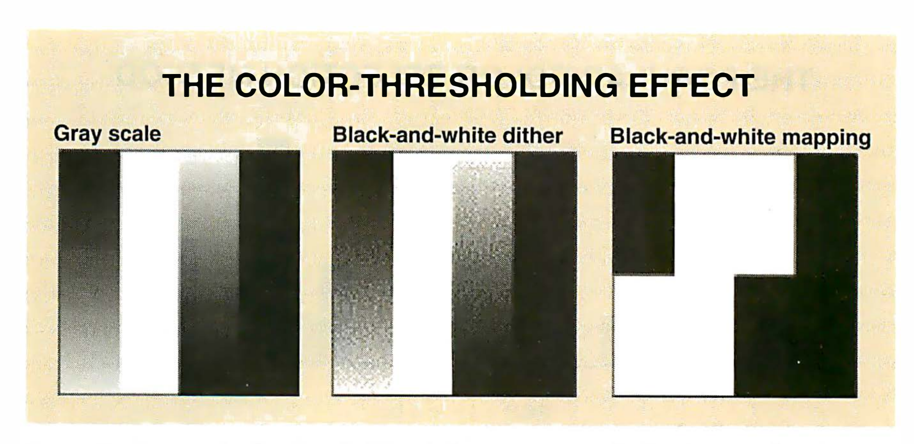


Figure 2: *The use of color thresholding helps to preserve the luminance of an image.*

Depending on the resolution of the inverse table, QuickDraw takes the high 3, 4 (the default), or 5 bits of the red, green, and blue color components of the color in question and constructs an index that's 9, 12, or 15 bits in size. This index is used to find the relevant entry in the inverse table. That entry corresponds to the index of the closest color in the color table.

But there's a problem here: Since the inverse color table uses only several bits from each of the source color components, multiple entries in the source color table could map to the same position in the inverse color table. Thus, the inverse table by itself is not adequate for finding the closest color match.

QuickDraw solves this problem by using a *hidden color list*, which keeps track of colors that map to the same location in the inverse table. If the inverse table lookup reveals a position to which multiple colors map, QuickDraw searches the hidden color list for the closest match. To find the closest match, QuickDraw finds the difference between the color's red, green, and blue components and those of each color in the hidden color list. The maximum difference of the three channels is kept for each color. The closest—and desired—color is the one that minimizes this difference.

Unfortunately, searching the hidden color list takes time. The time is negligible for objects (since usually only one color lookup is needed) and for indexed pixmaps (since at most only 256 color lookups are needed). However, with a direct pixmap as the source, searching the hidden color list for every pixel in the source takes a prohibitively long time, so QuickDraw doesn't do it. This results in QuickDraw's not using the best available color in some cases when the source is a direct pixmap and the destination is an indexed pixmap.

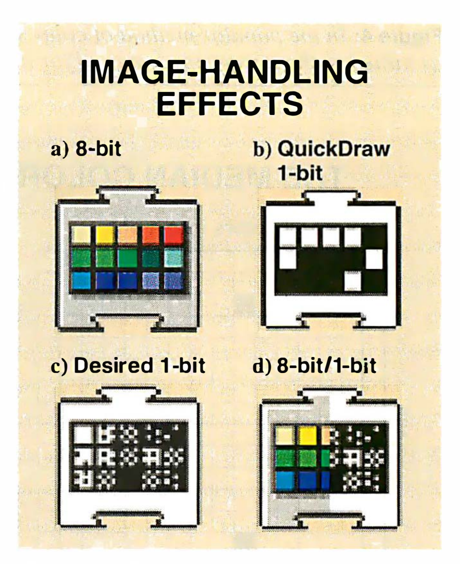


Figure 3: *Handling imaging under a variety of conditions.* **(a)** *A full-color image.* **(b)** *An image drawn to a 1-bit screen. Colors map to either black or white, which produces ambiguous results.* **(c)** *The desired appearance at 1-bit resolution.* **(d)** *The desired results when the image straddles an 8-bit-color monitor and a black-and-white monitor. Various QuickDraw color-mapping routines can resolve this situation.*

A color image overlapping an 8-bit monitor and a 1-bit monitor can create problems. Because the resulting color image is light, QuickDraw's algorithm for mapping colors produces mainly white, resulting in an image that is hard to recognize. There are two basic ways to overcome this problem: The first is to put smarter color translation in QuickDraw

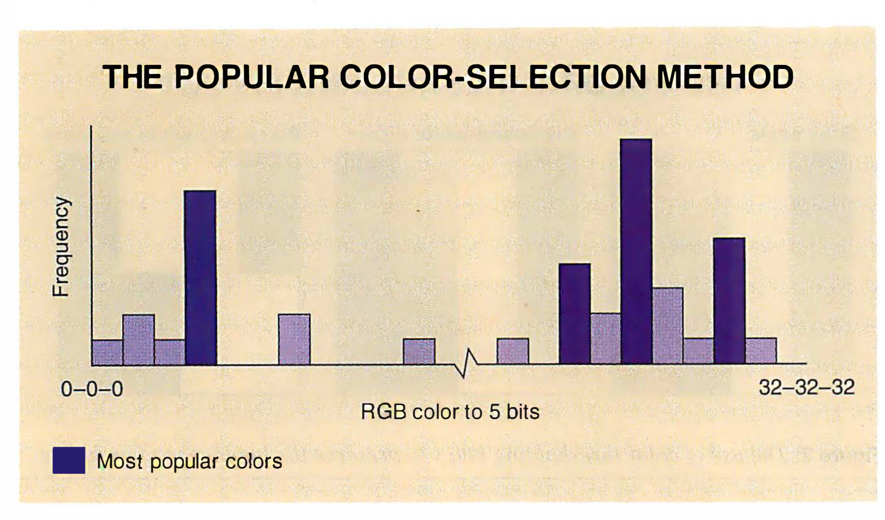


Figure 4: *In the popular method of color selection, the most frequently used colors, as tallied in the histogram, are used for the display.*

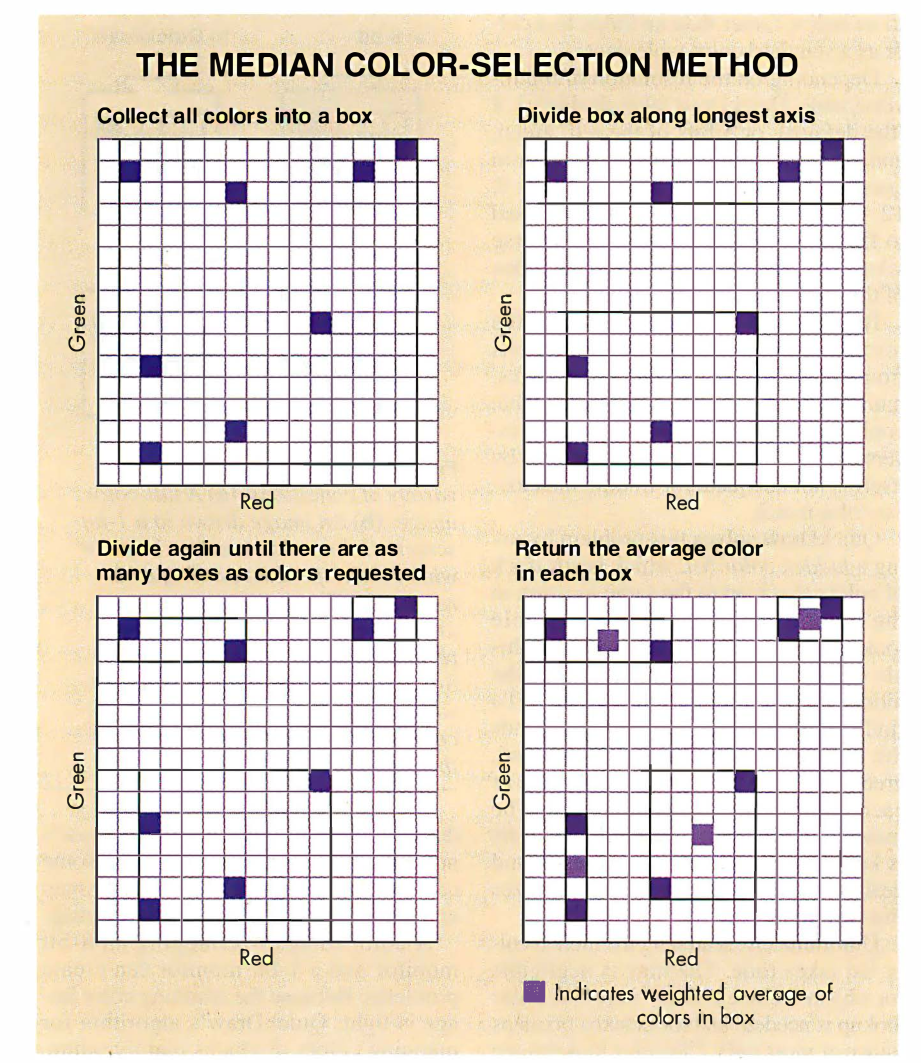


Figure 5: *The median method of color selection. The image's colors are grouped into a box that is divided until there are as many boxes as there are colors requested. The median colors within each box (marked with red) are used for the display.*

(which happened with 32-Bit QuickDraw 1.0); the second is to allow an application to draw independently to monitors with varying screen characteristics (which is possible with System 7.0 and higher).

Smart Color

QuickDraw's ability to map colors for geometric objects is limited to the algorithms I have already described. For drawing pixmaps, however, QuickDraw has the ability to perform an *error-diffusion dither*. Normally, the closest match available on the destination device is chosen to represent each color requested in the source. With dithering, the difference between the closest matching color and the requested color is kept as an error and added to the surrounding pixels. This ensures that the overall color (or, in the case of a monochrome image, the overall luminance) of the image is preserved. Figure 2 shows a gray ramp drawn using the 50 percent thresholding algorithm in dither mode.

Setting the dither flag results in substantially higher quality images, but the results may still be less than optimal. For example, a set of blue lines on a red background might simply look gray (with dithering) or black (without dithering) on a 1-bit display. Clearly, you can do better if you know what the characteristics of the destination device are.

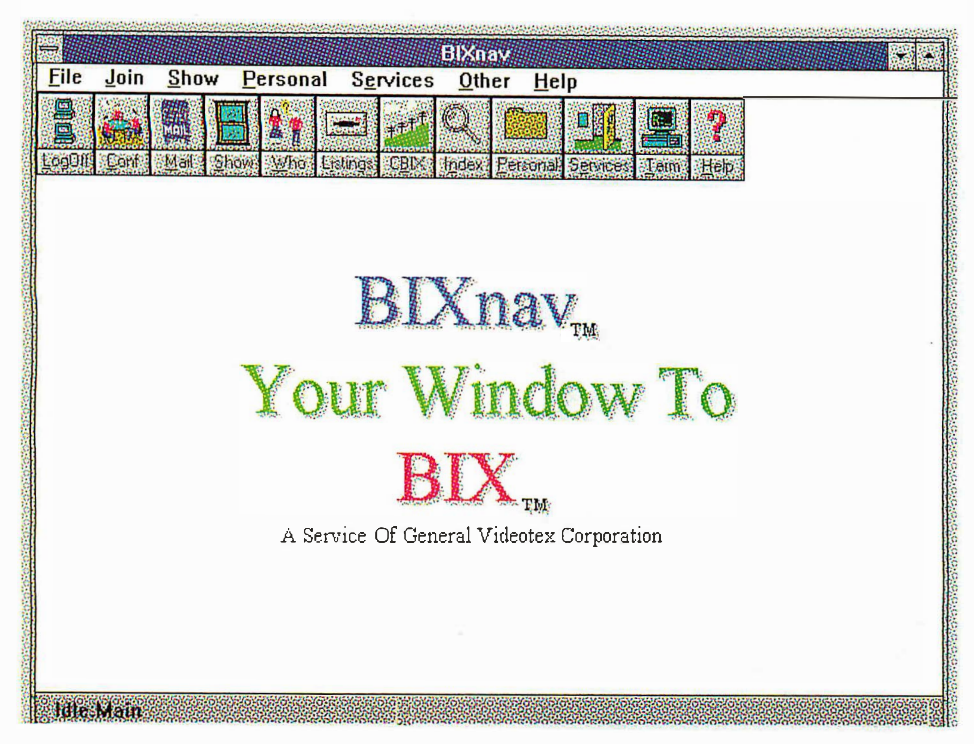
QuickDraw gives an application the ability to perform drawing updates on a device-by-device basis rather than simply drawing within QuickDraw's abstract model. At first glance, it might seem that examining the destination device's characteristics to determine how to draw a given image would contradict QuickDraw's device-independent model and would be frowned upon by Apple's Developer Technical Support, its "programming police." But it turns out that device-specific drawing integrates seamlessly with the rest of QuickDraw because QuickDraw supplies a Toolbox call for your use.

The call that permits device-by-device updates is called `DeviceLoop`. You call `DeviceLoop` with a region to update and a drawing procedure, and then `DeviceLoop` calls the drawing procedure once for every screen that the update region intersects. The drawing procedure is passed the characteristics of the device it is drawing to, and it performs the appropriate drawing for that device.

Figure 3 shows the type of problem that can be solved using the `DeviceLoop` call. Figure 3a shows the desired pixmap image in full color. Figure 3b shows this image as QuickDraw draws it to a 1-bit screen. The intent of the image is gone, however. Figure 3c shows the desired 1-bit image.

continued

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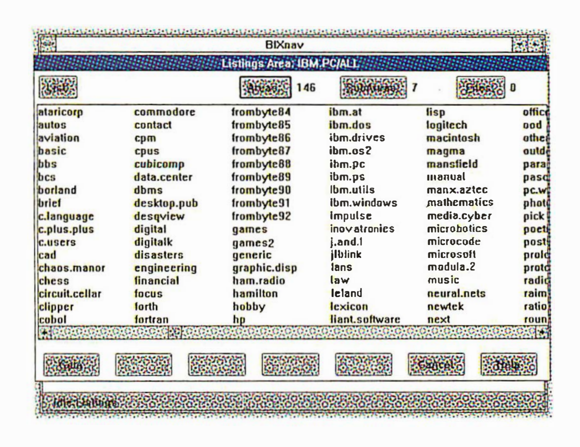
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Figure 6: *An example of the image results you can expect when using several color-selection mechanisms.* **(a)** *is the original image,* **(b)** *uses the colors in the standard 4-bit system palette,* **(c)** *uses the 16 most popular colors, and* **(d)** *uses 16 colors as calculated by the median-cut algorithm.*

Finally, figure 3d shows the image as it should be drawn when it crosses a full-color screen and a monochrome screen.

Palettes and the Picture Utilities

QuickDraw provides applications with an additional level of color control for indexed devices of 2, 4, and 8 bits (1-bit devices are generally set to black and white). While you have control over the screen depth and its mode (i.e., grays or colors), the application controls each window's colors via a part of QuickDraw called the Palette Manager. For example, if you select a pixel depth of 4 bits for the display, the application decides which 16 colors (actually only 14, since black and white are always present) to use for each window.

QuickDraw acts as the referee that ensures that the color requests of the frontmost window (i.e., the window you're working with, which thus requires the most accurate color representation) are met. Thus, the problem the application faces is finding the best palette to use. For example, a scanning application might want to determine what the best 256 colors are for displaying a given scanned image. Fortunately, QuickDraw has the facility for solving this problem. A set of routines called the Picture Utilities returns a palette of best-fit colors for use in displaying the PICT file or pixmap.

The application can select one of two available algorithms for choosing the best colors. The first is the *popular method*, which simply returns the colors that occur most frequently in the image. The second is called *median cut*; it returns colors that cover the range of colors used in the image. You can also implement your own algorithm for color selection that the Picture Utilities can use. For more information on finding the optimal color palette, see issue 10 of *develop*, Apple's magazine for programming techniques and tips.

Figure 4 shows the operation of the popular method. A histogram accurate to 5 bits for red, green, and blue is constructed. The Picture Utilities returns the most frequently occurring colors. With the median-cut method of color selection, all the colors are first grouped into one box. This box is divided along its longest edge (the green axis, in this case), and the colors are sorted by their green components. This produces two boxes. The box that has the longest edge is divided along that edge. This produces three boxes. This operation continues until there are as many boxes as there are colors requested. The average color in each box is returned as one of the median colors. Figure 5 shows how the median method works. This figure shows only the red-green axis.

To understand why there are several color-selection algorithms, look at figure 6, which shows four versions of the same image. Figure 6a is the original, 6b is drawn using only the colors in the standard 4-bit color table, 6c is drawn using the 16 most popular colors, and 6d uses 16 colors returned by the median-cut algorithm.

A Visual Tool

I've covered a lot of ground in this article, but the most important point to remember is that QuickDraw has a lot of power and flexibility. QuickDraw provides a common base on which programmers can build their applications. Its device-independent design allows Mac applications to run on a variety of Macs with widely different processors and video circuitry—even Macs using multiple monitors.

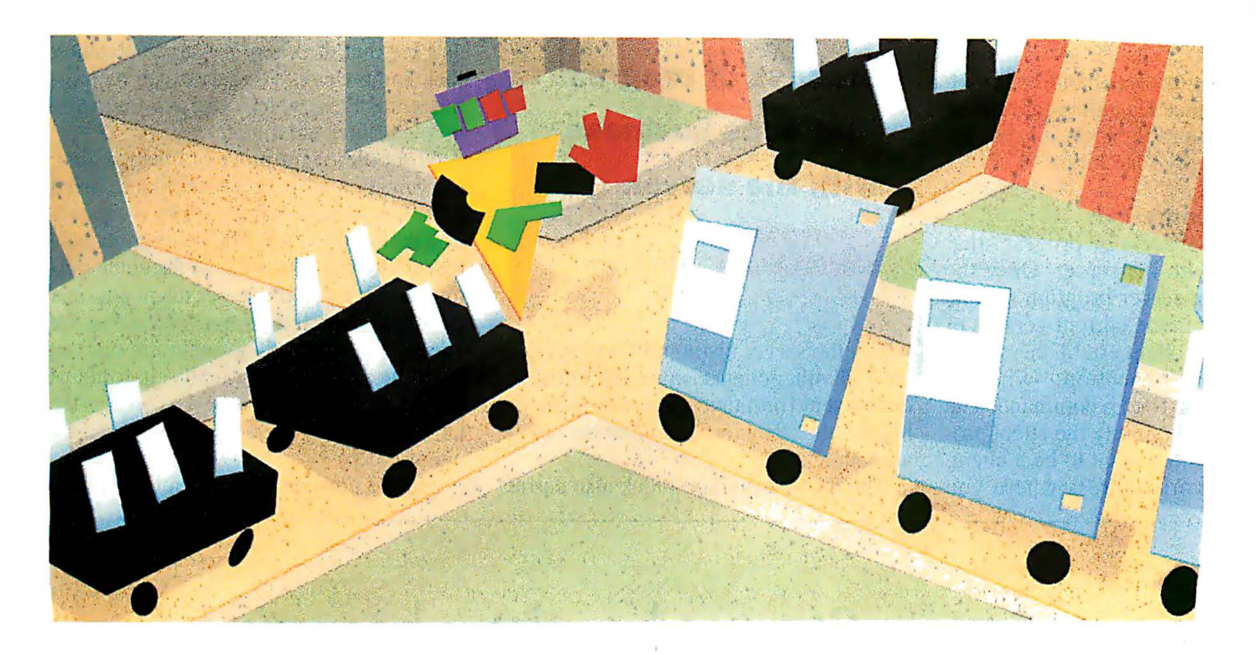
Furthermore, QuickDraw uses color mapping to produce visually optimal results, regardless of a display's size and depth. In those instances where you have a specialized application that needs precise color control, you can use the Picture Utilities or well-defined operating-system calls such as `DeviceLoop`. These functions allow you to choose the best colors with which to display a given image, without forsaking application compatibility.

QuickDraw is a versatile tool that lets programmers concentrate on obtaining powerful imagery while it handles the intricate details of making the results look their best no matter what screen is used. Thanks to these capabilities, the Mac is still regarded as the best microcomputer for color graphics and imaging work. Better still, QuickDraw is evolving to provide even better color control and to deal with complex problems, such as color matching, that users will demand solutions for in the near future. ■

Konstantin Othmer works at Apple Computer. He has worked on kanji TrueType, QuickDraw, and ColorSync and is the author of two books on computer software: Debugging Macintosh Software with MacsBug *and* Programming with QuickDraw, *both published by Addison-Wesley. You can contact him on BIX c/o "editors."*

RICK GREHAN

A SHARED RESOURCE ACCESS MANAGER, PART 2



The network resource access manager is a true client-server application for BSD Unix systems

Last month, I opened a discussion on resource access management and explored several ways to coordinate multiple programs requesting control of system resources. Resources can be any asset that your programs use in a multitasking or multiuser environment. Examples include *physical* resources, such as a network printer, and *logical* resources, such as database records.

This month, I conclude the discussion by looking more closely at the access manager I briefly described at the end of Part 1. The access manager is written for BSD Unix and is composed of two main pieces: a server program and a library of client routines. (I tried to isolate the network interface routines sufficiently that the access manager could be ported to other systems, such as NetWare.)

The server is a stand-alone program that runs as a background process, maintaining a list of available resources as well as handling the chore of determining whether an access request should be granted or denied. These access requests are transmitted to the server from one or more *clients*—separate programs running locally or on other workstations networked to the machine on which the server executes.

The client routines are a collection of C functions that you link into your application program. They take care of the dirty work of finding the server, establishing a connection, and so on. When it's time for your application program to, for example, obtain exclusive access to a printer or lock a record in a database, your program calls a routine in the library that does all the communicating with the server. Most of the action within this access management system revolves around both server and client routines manipulating a list of data objects. These objects carry descriptive information for resources, clients, connections, and access requests. I'll refer to such objects as *definition blocks*.

Handles and Blocks

Most of the important data structures that the server controls are dynamic: They come and go. Both the server and client library routines make use of a squad of such definition blocks; there is one for each entity handled by the system. Thus, any resource managed by the server is described by a definition block, any lock is described by a definition block, and so on.

The system makes heavy use of handles as shorthand identifiers of all data structures that a client program manipulates. If you've done any file-system programming, you're already familiar with how handles operate. Initially, your program provides a symbolic name of the entity on which it intends to work—in the file-system example, your program issues a call to the `open()` function, with the file's path name as an argument. The `open()` function returns a 16-bit handle that is bound to a data structure internal to the operating system.

continued

ILLUSTRATION: ROGER BOEHM © 1992

This structure carries everything the operating system needs to manipulate the file. Whenever your program wants to perform file I/O, it calls the appropriate function and passes only the handle. The operating system uses the handle as a pointer to the appropriate data function, so your program needn't use the file's path name over and over.

The resource manager uses this same principle. All definition blocks are ultimately referenced by their handles. This keeps information exchange across the network to a minimum (all handles are 16 bits long), and since a handle is an instant pointer to its definition block, it saves the server from lengthy searching.

Clients and Connections

A client is any process or program that does business with the server. Once the client locates the server program (via its network address in the current version of the software), the client establishes a digital dialogue—a connection—with the server by issuing a `login` command. The `login` command is simply the client process saying, "Hello. I want to be a client. Here's my network address where you should send all correspondence."

In response, the server builds a client definition block in which it stores the client's network address, and it sends the handle of the block back to the client. This handle becomes a kind of ID badge by which the server distinguishes that client from all other clients, since any future requests sent from that client will carry the handle (the client routines insert the handle automatically).

A client is any process or program that does business with the server.

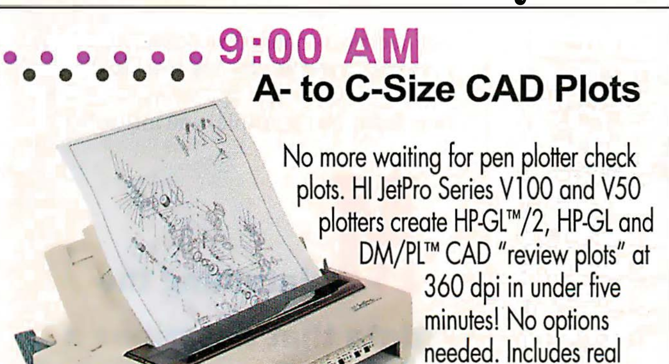
The client definition block also carries two counters. These counters indicate the number of active and waiting lock requests issued by that client. The server can use these counters to determine whether any cleanup has to be done in case the client unexpectedly issues a `log_out` command (which terminates the connection between client and server). For example, suppose a client process issues an exclusive lock on a printer queue and then logs out without releasing the lock. The server will examine the counters in the client definition block and see that the client has an outstanding lock somewhere. The server can then remove this lock, which otherwise might tie up the printer indefinitely.

From the client process's perspective, a connection with a server (often referred to as a *session*) is identified by a connection definition block. The connection definition block is analogous to the client definition block that the server maintains; that is, it contains all the information that the client process needs to maintain contact with the server. Specifically, it contains the server's network address as well as the handle that the server has assigned to the client.

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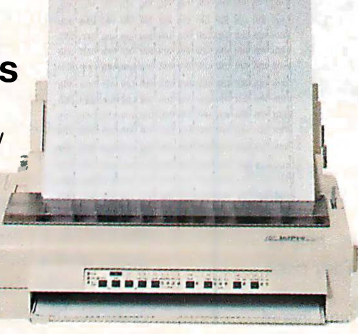
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defined by a connection definition block, a single program can log into the server more than once and appear as more than one client. For example, you might have a multithreaded program, each process of which accesses a single data file for different purposes. It's perfectly reasonable for each process to log into the server independently.

Maintaining the data that describes a resource is the server's job.

Resources

Maintaining the data that describes a resource—its name, the locking levels it permits, the number of active locks on the resource, and so on—is the server's job. All the data defining a particular resource is held in a resource definition block.

Each resource definition block is uniquely identified by two entities: its name (a string field of up to 32 characters) and a handle. The handle is implicit; it's simply the offset to the particular resource block in the memory region that holds all resource definition blocks. The name field is an explicit symbolic identifier that clients use to initially reference the resource. This string can contain arbitrary characters (except for a NULL character, which acts as a terminator), so your programs are free to establish any naming convention you consider appropriate. For example, network printers can be named NWPRT:LASER1 and NWPRT:JET2 and can be handled by the resource manager right alongside database records with names like DBF:GENLEDGER:00103 and DBF:GENLEDGER:02344.

When a client requests a lock on a resource for the first time, that client only knows the resource by name. Consequently, the server must respond to the request by searching the name fields of all active resource blocks. To facilitate this search, all the active resource blocks are chained together on a doubly linked list.

Why did I choose a linked list rather than some other structure with quicker

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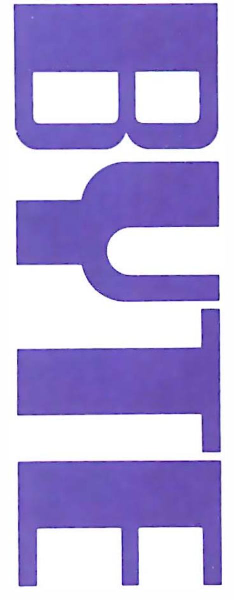
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search times, like a binary tree or a hash table? I had two reasons.

First, the only time the server must search the list is when a client makes an initial request for resource access. After that, the client uses only the handle to reference the resource definition block, so locating the block is instantaneous.

Second, there are two resource types—permanent and transient. The definition block for a permanent resource, such as a printer queue, remains active even if no locks are present on the resource. However, the definition block for a transient resource, such as a single record in a database file, is discarded after all active and waiting locks on the resource have been released. Using a doubly linked list simplifies the task of disconnecting blocks from the list.

Each resource definition block also has a pair of lists attached (see the figure). One is the list of all active locks currently enforced on the resource; the other is the list of all locks that have been forced to wait because they conflict with one or more of the active locks. (I'll go into detail about the members of these lists later.)

When a client issues a lock request for a resource, the server must decide whether that request should be granted (in which case the request goes on the active list) or denied (in which case the request goes on the waiting list). Rather than force the server to search the active list each time it has to make this decision, each resource definition block carries an array `curr_locks[]`, such that the value of `curr_locks[i]` is the number of locks currently active at lock level *i*. Also, the resource block carries an array called `lock_comp_tab[]` (short for *lock compatibility table*), whose contents show which lock levels are compatible with each other. The server can examine these two arrays and rapidly decide the fate of a lock request.

The code the server must execute to make a lock grant/deny decision is actually quite simple. First, given that a lock level is stored in variable `lockl`, the server builds a bit mask that has the bit corresponding to that lock level set to 1. You can do this with the following code:

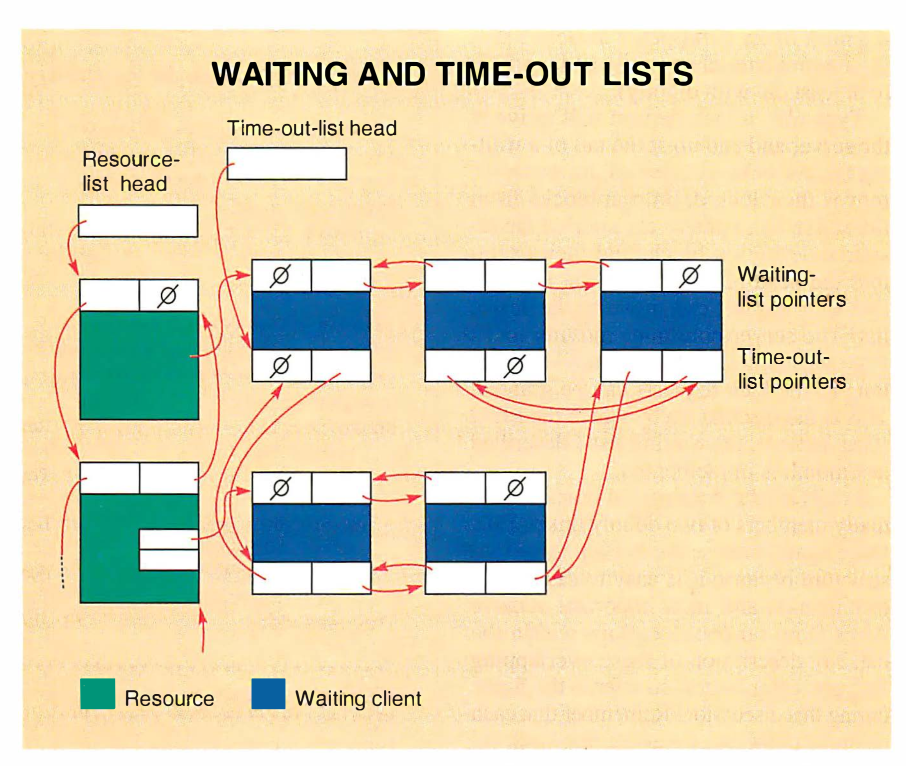
```
lockm=(uchar)(1<<lockl);
```

where `uchar` is a `typedef` that is shorthand for `unsigned char`. Now the resource manager can simply examine each member of the lock compatibility table. For any member in the table that has a bit set corresponding to lock level `lockl`, the manager checks the associated value in the `curr_locks[]` array. If that value is nonzero, then a lock already exists on the resource that is incompatible with the request being made. The code looks like this:

```
for(i=0;i<4;i++)
 if((lockl & lock_comp_tab[i])!
     =(uchar)0)
    if(curr_locks[i]!=0)
       return(FAIL);
```

If execution makes it out of the above loop, the lock can proceed. (I've taken some liberties with the code to preserve clarity; although I haven't shown it here, the two arrays are actually components of the structure that defines a resource definition block.) Note that the number of lock levels is easy to expand by simply increasing the size of the `lock_comp_tab[]` and `curr_locks[]` arrays and increasing the limit of the above `for` loop accordingly. The lock comparison table is currently defined as an array of `unsigned char`, which means that the current program can support up to eight lock levels with those minor modifications.

As I mentioned above, the server carries all the detailed information about a resource. Initially, a client program knows only the resource's name; it loads that name into the first lock request for the resource. The server will return the resource's handle in response to this request, and thereafter the client program uses that handle to identify the resource.



Attached to each resource is a list of lock definition blocks representing pending lock requests. Lock requests enter the lists in order of arrival; pending requests are also connected to a systemwide time-out list. Requests are attached to the time-out list based on the length of time each associated client will wait for lock request service.

Locks: The Server View

A lock definition block serves to record a lock request that a client posts. You recall that all lock definition blocks live on one of two lists and that these lists are anchored to a resource definition block associated with the resource being locked. The most important component of a lock definition block is the lock level. It guides the server's decision on whether the lock can proceed or must wait. The server also uses it to update the contents of the resource definition block's `curr_locks[]` array.

Regardless of what list it's on, a lock definition block also holds the handle of the resource to which it's attached, as well as the handle of the client making the lock request. The resource handle lets the server rapidly locate a lock's target resource in case the resource definition block must be modified to reflect a change in the lock. The client handle is necessary if a client issues a log-out and still has lock requests active or on waiting lists. When this happens, the server must scan all resource active and waiting lists and remove those lock definition blocks associated with the client (a time-consuming job, to be sure, but one that should happen infrequently;

it's most likely to happen if a client's program terminates abnormally and is trying to at least die with dignity).

Typically, a lock request will arrive at the server and end up at the tail of a waiting list. As locks are released, the server removes their lock definition blocks from the active list, updates the state of the resource definition block, and then examines the head of the waiting list to see if that lock request can move to the active list. The server continues moving locks from the waiting list to the active list as long as the lock requests can be granted. This is the mechanism by which the FIFO (first-in/first-out) waiting list I described last month is implemented.

Locks on the waiting-list items are actually members of two doubly linked lists. Once again, I chose the doubly linked list structure because it is easy to rapidly attach items to and, most important, remove items from random locations within the list. My description of these overlapping lists gets complicated, so refer to the figure during this discussion. Remember that each resource possesses a waiting list. Lock-request definition blocks are attached to the end of this list as they arrive at the server. This is a FIFO queue.

However, each lock request also carries an associated time-out value. This value tells the server how long the client is willing to wait for the associated request to be serviced. The resource manager maintains yet another list to which all waiting lock requests are attached in order of ascending time-out values. This list, the *time-out list*, crisscrosses the waiting lists of every resource in the system (see the figure).

At the head of the time-out list is the first request due to time-out; next is the second request due to time-out; and so on. When a lock request arrives that the server determines must go on a waiting list, the server "wires" the request into the time-out list. At regular intervals, the server examines the first request on the list to see if that request has timed out. If so, the server removes the request from the system and sends a "request timed out" response to the client. The server repeats this process, removing the new first request if it has timed out, until it encounters a request that has not timed out. Since all requests in the system are on the time-out list, this saves the server considerable time; the server doesn't have to repeatedly examine all requests on all the waiting lists to see which ones have timed out.

Listing 1: *Definitions for the primary structures used on the client side.*

```
/**************************
** Connection definition **
**************************/
typedef struct {
   short client_hand;      /* Client handle */
   int socket;         /* Server socket */
} connect_def;

/****************************
** Access definition block **
****************************/
typedef struct {
short result;              /* Result code of request */
    char name[32];         /* Resource name */
    char template_id[4];   /* Template ID string */
    short resource_hand;   /* Resource handle assigned by server */
    short lock_hand;       /* Lock handle assigned by server */
    short lock_level;      /* Lock-level request */
    ulong wait_timeout;    /* Maximum time to wait for request */
    ulong quantity;        /* Used for multi-instance resources */
} access_def;              /* Access handle */

/**********************************
** Resource definition structure **
**********************************/
typedef struct {
    char name[32];                 /* Name */
    short flags;                   /* Definition flags */
    uchar lock_comp_tab[4];        /* Lock compatibility table */
    short act_clients_allowed;     /* Active clients allowed */
    short wait_clients_allowed;    /* Waiting clients allowed */
} resource_def;
```

Locks: The Client View

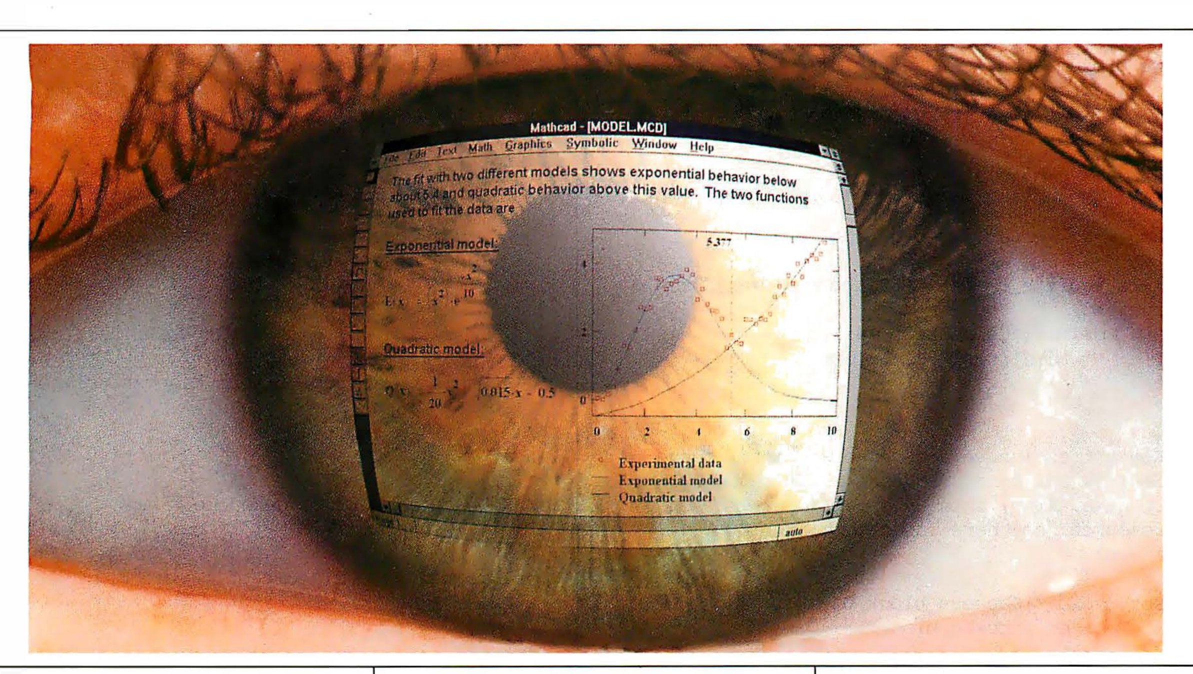
For every lock request that a client submits to the server, the client program creates a data structure similar to the lock definition block. This structure is known as an access definition block, and the act of issuing a lock request to the server actually amounts to the client sending a copy of the access definition block to the server. The server attempts to satisfy the request, modifies the contents of the access definition block depending on whether or not the request succeeded, and transmits the results back to the client.

Inside an access definition block, you will find not only a resource name field, but also a resource handle field. When the server receives an access request block, it examines both fields. If the resource handle field contains a negative number, the server assumes that this is the client's first access request. So, the server must look up the resource by name and uses the contents of the resource name field to guide its search. Otherwise, the server can use the resource handle field to locate the resource directly. The access definition block also carries lock-level and time-out fields that the server must move into the corresponding fields of the lock request block.

In most cases, a client will request access to a resource that is already active in the server (i.e., has an active resource definition block). However, a client may make an access request to a resource that is not currently active; then the server will have to build a resource definition block on the fly. An example is when a client submits a request to lock a particular record in a database. The server certainly doesn't want to keep an active resource entry for every possible record in that database—there could be millions. This is an example of a temporary resource: one whose definition block is created only when a client issues a lock request and is deleted when all requests on that resource have been released.

To facilitate the rapid creation of temporary resource definition blocks, a client's access request also carries a four-character template ID string. When the access request arrives at the server, if the server finds neither the resource's name nor its handle, it uses the template ID to read a resource definition block template—a kind of fill-in-the-blanks form that the server can copy into a new resource definition block. The template defines such things as lock levels permitted, number of active clients permitted, the lock compatibility table, and so on—everything the server needs to rapidly construct the new resource definition block. (The server builds its in-memory library of templates by reading a

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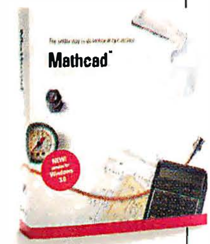
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Circle 126 on Inquiry Card.

Listing 2: *In this simple example, a client application logs into the server and then requests exclusive access to a printer queue named PQUEUE:LASER1. After the client has completed use of the queue, the client releases the lock and logs out from the server.*

```
/*
** We presume that the server port has been
** decided on and is globally defined as
** S_PORT. We also presume that s_name points
** to the server name string.
*/

/*
** Login to server given by s_name.
*/
rval=rs_login(s_name,S_PORT,&connection_block);
if(rval!=0)
{       printf("Connection failed, error:
           %d\n",rval); exit(0);
}

/*
** Request exclusive access to a printer queue
** This is our first request, so we request it
** by name. Also, this is a permanent
** resource, so there is no template ID
** string.
*/
memset((void *)&access_block,0,
        sizeof(access_block));
   /* Name */
memmove(access_block.name, "PQUEUE:LASER1",13);
   /* Don't know handle */
access_block.lock_hand=-1;
   /* Exclusive lock */
access_block.lock_level=RS_LOCK_EXCL;
   /* Wait 100 secs */
access_block.wait_timeout=(unsigned long)100;

rval=rs_req_access(&connection_block,
   &access_block);

/*
** The code in rval indicates whether
** communication with the server somehow
** failed. The result code of the request is in
** the access block.
*/
if(rval!=0)
{       printf("Server communication failure:
           %d\n",rval); exit(SERVER_COMMERR);
}
if(access_block.result!=0)
{       printf("Request failed: %d\n",
           access_block.result);
        /*
        ** Code to handle request failure goes
        ** here....
        */
}

/*
** At this point, the client has exclusive
** access to the print queue.
*/

/*
** Release access to the queue.
*/

rval=rs_rel_access(&connection_block,
   &access_block)

/*
** Again, the code in rval indicates whether
** communication with the server failed.
*/

if(rval!=0)
{       printf("Server failure: %d\n",
           rval); exit(SERVER_COMMERR);
}

/*
** Log out. We'll ignore any errors at this
** point, but go ahead and wait for a server
** response.
*/

rs_logout(&connect_block,RS_LOGOUT_WAIT);
```

predefined file at start-up time. You can load as many templates as your applications require, up to your memory limits.)

Show and Tell

Listings 1 and 2 present a short example of how a client application would call the access manager to gain an exclusive lock on a print queue. Listing 1 is a collection of the structure definitions used by the client application; refer to it as you look over listing 2, where the real action occurs.

The code in listing 2 shows how a client would log into the server (i.e., set up a connection) and issue a lock request. Presumably, if the request is granted, the application will proceed to access the resource (in this example, copy printer data into a file). Once finished with the resource, the client issues a release command and then logs out from the server.

As usual, there are numerous additions you can make to tailor the system to your particular needs. For example, you may want clients to log in with an associated name, so if something goes wrong, you can create some auditing information and determine which client messed things up.

Another addition would be to add a monitoring screen that you can call up in case the system appears to be exhibiting difficulties. This screen would let you peek into the server and see which clients hold locks on which resources.

My requirements, however, are modest. I need only a systemwide lock manager that can handle record locking as easily as file locking, and file locking as easily as queue management. Perhaps the best attribute of this system is its extensibility; a variety of management functions can be brought under the control of a single program. Simplification is always welcome in the programming world. ■

Editor's note: *The listings in this article are available from BYTE in electronic format; see page 5 for details.*

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BARRY NANCE

SOFTWARE WITH CURVES

Bézier curves, inside and outside Windows, and keeping Windows menus alive

If you want to draw curves in a Windows program, you can use the Bézier library routines in the Windows 3.1 SDK (Software Development Kit) or you can roll your own. With the latter approach, you have more control over the behavior of your program. You can also use the same basic routines in non-Windows graphics programs; you'll just have to remove the references to a Windows device context and substitute whatever is appropriate for the other graphics environment.

This month's software, CDRAW, is a Windows program that interprets an EPS (Encapsulated PostScript) file and displays the result in a window. I've also included a sample EPS file, created with Arts & Letters from Computer Support (Dallas, TX). The file contains dozens of curve-drawing commands. Even the text displayed on-screen exists in the file as sets of draw curve and draw line commands.

CDRAW is a C program that you can compile into a Windows executable file with a Windows-capable C compiler from Microsoft, Borland, or Watcom. The listings disk also contains the associated resource files (i.e., .RC and .ICO) for building the Windows application. The icon for CDRAW shows "EPS" and a picture of an eye—it also shows I'm not much of an artist!

When you pick the Draw menu item, CDRAW reads and interprets the EPS data. CDRAW processes move to, line, and curve commands embedded in the file. To draw a curve, CDRAW recursively invokes logic that uses the de Casteljau algorithm for Bézier curves. I wrote the de Casteljau routine as a separate C function, so you can scavenge the code and insert it into your own programs whenever you want to draw curves, whether inside or outside Windows.

Bézier curves and quadratic b-splines are both methods of approximating smooth curves, and both have applications in font technology. TrueType fonts are based on quadratic b-splines; Adobe Type 1 fonts are based on Bézier curves (4-point Bézier curves, to be specific). You need to store more data points to represent a TrueType font than an Adobe Type 1 font, but TrueType fonts require less computation. Nevertheless, Bézier-curve drawing, especially with the de Casteljau algorithm, is fast. So fast, in fact, that it's generally faster to convert quadratic b-splines to Bézier curves before drawing them.

If you find that CDRAW runs too fast to follow, you can slow it down by selecting the Slow Speed menu option. In this mode, CDRAW pauses for a second after each drawing command.

CDRAW doesn't turn the cursor into an hourglass while it draws. Instead, the program strategically calls the `PeekMessage()` Windows function to ensure that the message queue is emptied on a timely basis. If you click on the left mouse button, CDRAW sets a flag that tells the drawing function to stop. Because the `PeekMessage()` technique keeps the menus "alive" while the program draws, you can pick Slow Speed or Fast Speed while the drawing is in progress. ■

MAC/Tom Thompson

Zync Syncs Macs

Nothing creates more havoc than being out on the road, PowerBook in hand, and discovering that you left an essential file or application behind on your office Mac. You can head off trouble by simply checking that your PowerBook files match, or are "in sync" with, those on your desktop Mac. This seems easy enough, but it's easy to overlook some obscure folder or file buried deep in a collection of folders.

Fortunately, Ricardo Batista's Zync comes to the rescue. Zync, a freeware utility, compares the files of two networked Macs and makes both of the file systems match. It copies missing files to the machine that is lacking them and makes sure that the most recent copy of each file is on both computers. You can select an entire drive or just a single folder for the synchronization process. Zync requires System 7.0's file-sharing feature.

UNIX/Ben Smith

The Bit-Map Translators

Few subjects more resemble the post-Tower biblical community of Babel than image file formats. Different applications use a wide variety of formats (e.g., TIFF, GIF, and PCX), and translating between formats is a common problem.

Several sets of public domain translation utilities have grown up around the idea of translating all these formats to a common base format. From the base format, you can convert to whatever format you need. The least of these base formats (and the seed from which all these utilities sprang) is PBM (Portable Bit Map), developed by Jef Poskanzer. Now there are also PGM (for gray scale), PPM (portable pix map, for full color), and Michael Mauldin's FBM (Fuzzy Bit Map). This month's listings include utilities by these authors for working with all four of these formats, with features including sizing, scaling, retoning, halftoning, and quantizing, as well as translating.

Editor's note: *Software Corner highlights public domain, freeware, and shareware programs. The programs are available in electronic format. See "Program Listings" on page 5 for details. We solicit your contributions. We pay $50 for any program we use. Write to: Software Corner, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

In Search of an Object-Oriented File System

JON UDELL

Windows, like the Roman god Janus, has two faces. Program Manager surveys an abstract landscape of groups and items, and File Manager presides over a set of real tree-structured disk volumes. No such logical/physical duality confronts Mac users because Finder's nested-folders-and-icons view of the contents of a disk maps directly to actual directories and files. To reorganize your view of programs and documents, you have to literally haul them around on the disk. Deep within the Mac OS, the windowing and file systems conspire closely to make this approach fast and effective.

Windows 3.0, unable to emulate the Mac in this regard, charted a new direction. You saw programs and documents primarily as collections of Program Manager objects. In principle, this was a great thing. You could create pseudodocuments as program items configured to load data files. Thus, the group "Weekly reports" might contain the item "Week of February 12." This would launch WRITE.EXE and feed it the file C:\JON\WEEKLY\FEB1292.WRI.

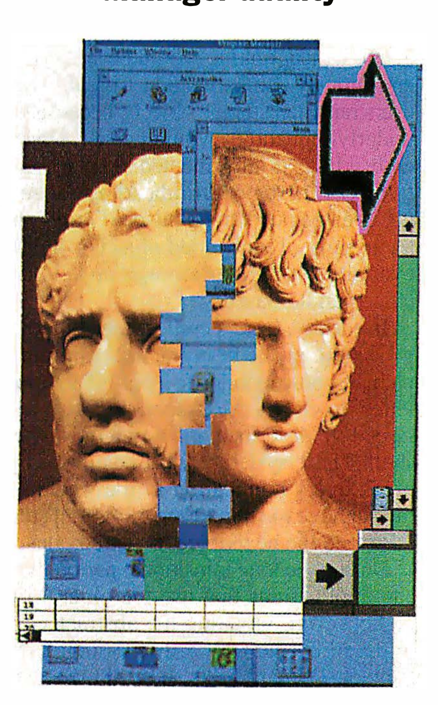
Unhappily, the item "Week of February 12" didn't have all the properties a document should have. You could launch it, but you couldn't search for it. For that, you went to File Manager and hunted for, say, "FEB*.WRI"—*not* "Week of Feb*." Worse, you had two sets of copy/move/delete semantics to contend with. Are you copying/moving/deleting a Program Manager object—merely a pointer to a file? Or are you working with a File Manager object—the file itself?

Windows 3.1's new drag-and-drop features drove Windows' two faces even farther apart. In version 3.1, you can drop a file onto Print Manager to print it or onto the icon of a running program to load it into that program. But only File Manager can act as a drag-and-drop donor. So your effort to hide FEB1292.WRI behind a Program Manager abstraction comes to naught if you want to use version 3.1's direct-manipulation printing feature. You have to reveal the object's physical location, by File Manager navigation, to be able to drag it to the printer.

New Windows and OS/2 Desktops

Three new Program Manager replacements—Norton Desktop 2.0, WinTools, and NewWave 4.0—wrestle with the duality of the Windows desktop. There's also the OS/2 2.0 Workplace Shell, IBM's effort to smooth out a similar division that had plagued the Presentation Manager desktop. All four products add something that the original Windows and PM desktops lacked—a fully hierarchical logical view.

Only an object-oriented file system can resolve the File Manager/Program Manager duality



At first blush, the nested folders, groups, or objects seem to make these environments more Mac-like. But there's always a separate file manager hanging around, because none of these shells can free you completely from the need to navigate the file system. Further, as the logical view grows more ambitious, the logical/physical duality worsens.

While Norton Desktop and WinTools do allow nested objects, they don't really push these as the preferred method of document organization. The tip-off is that neither product can search its respective object name space. To find a "Weekly report" object, you have to remember where you put it or bypass the logical view and use a file manager to track down its data file directly. Clearly, you're not expected to build a logical view that rivals the complexity of the physical one, which for typical users can involve thousands of files and many levels of nested directories.

NewWave and the Workplace Shell, on the other hand, do want you to build elaborate logical views, and they include tools for searching the logical namespace. Both enable you to pull existing material into their logical views (when installed onto a DOS partition already full of programs and documents) and to capture newly created material as well.

The Workplace Shell's migration tool automatically captures DOS, Windows, and OS/2 applications as Workplace Shell *program-file objects*, but it's up to you to create *data-file objects* by dragging data file icons from the Templates folder and specifying the applications that created them. NewWave goes further, automatically migrating both programs and documents into its environment.

Because NewWave's list of document types is richer than OS/2's and more closely coupled to program-launch behavior, things integrate much more smoothly. NewWave takes great pains to capture

your work in its object database. That's a given if you run NewWave-aware applications like TextNote, the Notepad-like text editor included with the package. The desktop's Create a New dialog box offers TextNote as an object type.

When you create a TextNote, you get an appropriately typed document object that you can drag from folder to folder and that launches the TextNote editor when you double-click on it. Unlike Notepad, TextNote's Save As menu option doesn't invoke Windows 3.1's Common File dialog box. You can rename the *object* using Save As, but NewWave won't let you get at the file.

It does have a real DOS identity—out of perverse curiosity, I found that "Memo to Anne re: PC EXPO" was stored as C:\HPNWDATA\HPOMF002\0000006B.SRD—but you don't need to know that to search for, edit, delete, or print the document. You do, however, have to reconstitute a DOS identity for the file if you want to, say, copy it to drive A. NewWave provides the admittedly awkward Detach DOS File from Object function for this purpose.

Alternatively, you can register non-NewWave-aware applications as object types. Because real NewWave applications are scarce, this is the usual arrangement. If you add Notepad to the set of types known to the Create a New dialog box, things appear to work just as with a TextNote.

There are subtle differences, however. You can have a Notepad object refer to a normal DOS text file "in place," or you can choose to have NewWave move the data into its object database. If shift-clicking on the object's name reveals a DOS path name, NewWave doesn't own its storage; otherwise, NewWave does. The distinction matters. If you dump a DOS-managed object into the Waste Basket, you'll just delete the object; if you trash a NewWave-managed object, you'll delete its data as well. With two file systems coexisting, conflicts are inevitable.

Ultimately, neither NewWave nor the Workplace Shell can guarantee that you'll be able to find a given document by searching the logical namespace rather than the physical one. Users must constantly decide whether to commit a newly created document to one environment or the other. Even if you're a true believer in the value of a logical scheme, applications (NewWave-aware ones excepted) are constantly working to subvert that belief.

They happily offer File Save dialog boxes that invite you to write straight to the file system without the knowledge or consent of the desktop environment. For today's applications, the ability to name and use files is a sacred and inalienable right. Until that changes, the marriage of Program Manager and File Manager can never be truly consummated.

Farewell to Filenames

Imagine how an OOFS (object-oriented file system) would help solve this dilemma. Suppose the operating system doled out to applications not named chunks of disk space but opaque handles to storage objects. These objects would be registered in a class hierarchy. A text editor might request an object of class Text, subclass ASCII; an image editor might ask for an object of class Image, subclass GIF. And they'd have long descriptive names completely unrelated to their storage location, which the operating system would determine based on their handles.

The key change in OLE 2.0 will be in-situ interaction.

You'd search for storage objects by descriptive name—which wouldn't need to be overloaded with type information—or by type. Thanks to the class hierarchy, you could conduct general searches (e.g., all images) or specific ones (e.g., all GIF images). Object linking would be simplified enormously. Links wouldn't break when users renamed storage objects, because the underlying handles would persist. Object embedding, as implemented today in OLE (Object Linking and Embedding), would not even be needed. Its raison d'être—the anonymity of embedded objects—would evaporate if regular storage objects became handle-based.

Ironically, OLE's embedding technology may offer the best practical migration path. Suppose Windows 4.0 or NT 2.0 provides an OOFS API supporting the features I've described and an OOFS-aware shell. These systems won't be allowed to break every application in the world, so they'll have to support the old file-system APIs and the new object-oriented ones.

During the long transitional period, how can applications that use the older APIs be kept from violating the abstract view imposed by the OOFS-aware shell? The Hewlett-Packard folks showed me an experimental version of NewWave 4.0 that solved this problem in an intriguing way. They demonstrated NewWave launching Paintbrush in embedding mode—just as if you'd started the application from an OLE client like Write using Insert Object. HP had Paintbrush thinking that NewWave was an OLE client while it slyly redirected the bit-map data that Paintbrush pumped through the OLE pipe into NewWave's object database.

In normal OLE, the anonymous chunk of data that is an embedded object resides within the client-created document, accessible only to the client. HP's clever hack exposed the name and type of that data to systemwide access while hiding its location. Unfortunately, this feature didn't make the final cut, so it's now slated for the next release of NewWave. Still, hats off to HP for championing the object-oriented file system we all know we need and for blazing a trail that could take us from here to there.

Meanwhile, Microsoft is busily nailing down the specification for OLE 2.0. For users, the key enhancement will be *in-situ interaction*. In OLE 1.0, when you activate a Paintbrush object that's embedded in or linked to a Write document, an instance of Paintbrush launches in a separate window. Once these applications comply with OLE 2.0, Paintbrush will simply take over Write's window, so Write "becomes" Paintbrush while the embedded/linked object is active.

Under the covers, the client (e.g., Write) and the server (e.g., Paintbrush) will exploit a vastly improved method of communication. OLE 1.0 requires the client to pump all of an embedded object's data through a DDE pipe to the server, which does its editing and then pumps everything back. OLE 2.0 introduces a new object storage system, the "Docfile," which gives servers direct read/write access to objects embedded in client-owned documents. (Optionally that access may be transactional, so a user could choose to commit or roll back edits performed during in-situ interaction.)

A Docfile, contained within an ordinary DOS file, can itself contain a mixture of embedded or linked objects and subsidiary Docfiles. When you link to an object in a Docfile, you're no longer using a DOS filename, but rather an OLE 2.0 "Moniker"—that is, an opaque object handle. Here's another evolutionary path that will, hopefully, lead someday to a full-blown OOFS. ■

Jon Udell is a BYTE senior technical editor at large. You can reach him on BIX as "judell."

ASK BYTE



Weather by PC

I am looking for a system to receive and store weather maps on my computer. I have a shortwave radio and an IBM AT. Where can I find a radio-to-PC interface?

Pascal Gilles
Frascati, Italy

Going to a commercial service is probably your best solution. Global weather maps and reports are currently available to members of CompuServe (5000 Arlington Centre Blvd., Columbus, OH 43220, (800) 848-8990 or (614) 457-8600) who use the optional CIM (CompuServe Information Manager) software. You need CIM 1.3 or higher for DOS machines and version 1.5 for the Mac.

CIM lets you access current conditions and a 72-hour forecast for the U.S., Canada, and 85 additional cities worldwide, with hourly updates. You can also receive current conditions, a 24-hour forecast, and satellite maps for the U.K./Ireland, continental Europe, the Pacific Rim, and Australia/New Zealand in 16-color or black-and-white graphical representations.

For Mac users in the U.S., Mainstream Data (420 Chipeta Way, Suite 200, Salt Lake City, UT 84108, (801) 584-2800; fax (801) 584-2831) has released Mainstream Newscast, a broadcast information service that delivers news to users in the U.S. and Canada via FM radio or satellite.

Mainstream does not yet have a weather service, but you can monitor business and general news from such sources as Associated Press, Reuters, Knight-Ridder, Market News Service, Newsnet, PR Newswire, Business Wire, Sports Network, and others. Along with software, you need an FM antenna or satellite dish, coaxial cable, and the Mainstream Intelligent Data receiver, which receives the FM or satellite signal and formats it for use by the computer.

Prices for news delivery to a stand-alone Mac start at about $50 per month. The software and hardware prices range from $495 for FM service (in 12 U.S. cities only) to $990 for a small-dish satellite connection (U.S. and southern Canada only).

I'm not aware of any such services in Europe. Perhaps some of our readers can offer suggestions.—Stan Wszola

Column Conundrum

I am looking for an editor that I can use to draw up a seven-column chart. I want something that will let me edit font size, line spacing, and page breaks easily. Do you know of anything that would meet my needs?

Sara Little
Amherst, NH

The BYTE Lab has had to assemble many tables for comparative reviews. Many of the newer high-end word processing programs will work. Microsoft Word for Windows 2.0 has built-in table creation and editing functions, and it supports a table with up to 31 columns and an almost unlimited number of rows. Word can convert ASCII text to a table, where table cells can be sized, copied, and moved. You can insert the table directly into an article's text and retain the correct formatting.

Alternately, you can use a spreadsheet program like Borland's Quattro Pro or Microsoft Excel. They can't manipulate text as well as a word processor does. but you get the advantage of built-in calculation functions. Many spreadsheet programs let you rotate cell locations to change the table's format.

If you want the best of both worlds and have two applications that support OLE (Object Linking and Embedding), you can embed a table created in a spreadsheet program directly into your word processing file. Excel and Word offer this feature. Without OLE, you would have to convert the spreadsheet file into a text file before importing it into your word processor. In the process, you'd lose all your formatting.—Stan Wszola

Which Unix?

I plan to buy a 33-MHz 486 and run DOS and Unix on it. I will use this machine as a single-user multitasking system, typically for `xterm`. Which Unix should I use? Are the X Window System versions from The Santa Cruz Operation and Interactive fully compatible with the MIT version? How should I configure the system?

Claudio Fornaro
Turin, Italy

The BYTE Lab has tested the most recent releases of SCO and Interactive Unix. Both are good. When Interactive comes out as Solaris, it should be even better. SCO is more popular and is well known in the VAR world, but it is not a typical Unix environment. It will be a long time before it becomes System V release 4.0—if ever. SCO Unix is available from The Santa Cruz Operation (400 Encinal St., P.O. Box 1900, Santa Cruz, CA 95061, (800) 726-8649 or (408) 425-7222; fax (408) 425-4222). For Interactive Unix, contact Sunsoft (2550 Garcia Ave., Mountain View, CA 94043, (415) 960-3200; fax (415) 960-9131).

BSDI Unix from Berkeley Software Design (3110 Fairview, Suite 580, Falls Church, VA 22042, (703) 876-5040; fax (703) 876-5059) includes full source code. Judging by the beta copy we received recently, BSDI Unix looks like the best choice for anyone who plans to do any serious system hacking.

You can install these operating systems on 30-MB drives, but you won't have enough room for the compiler, libraries, and other niceties (e.g., the man pages, networking, and X). I run SCO Unix with the developer's tools and X on a system with a 150-MB hard drive and 8 MB of RAM. Interactive Unix is about the same. SCO Open Desktop will hog all 150 MB if you install everything, including the database server.

The MIT sources are raw source code. Thus, they require considerable work to install on any system. The most recent versions of X servers for Intel-based Unix support only through version 11 release 4.

If you don't plan to run X, a 9-inch monitor is fine. I find that Super VGA and a noninterlaced 17-inch display

are preferable for X. If you aren't working with graphics, however, you can get by with much less. My SCO system, which I use primarily for writing books, has a VGA card with a noninterlaced 13-inch screen.

Get a system that has maintained a reputation for dependability for at least a few years. Don't get the motherboard with the newest technology; there may not be drivers or utilities for installing Unix or Unix drivers for its devices. The same goes for device controller boards.

As for memory, 8 MB is tight, but sufficient. You will need to do some system tuning to be sure that the process tables don't overflow. At less than US$100 per megabyte of RAM, it is worth going to 16 MB. Be sure to install the memory before you configure your disk, or at least set aside a swap space for the amount of memory that you intend to install. Reconfiguring your disk for a bigger swap space after the fact is a lot of work on Intel-based systems, because you have to repartition it.—Ben Smith

Pixels, Pixels Everywhere

I found "Monitors: Beyond VGA" (May BYTE) helpful, but I am puzzled about the relationship between resolution and screen size. On page 210 you say, "Screen characters shrink each time you boost screen resolution." Does this mean that increasing screen resolution merely crams more of the "page" on the screen? How can I increase the resolution of the characters and images on the page?

Donald V. Etz
Kettering, OH

For a given monitor of any size, character (and picture) size decreases as screen resolution increases. The reason is simple: A character defined as 9 pixels wide by 12 pixels high will always display as a 9- by 12-pixel matrix. Increasing resolution simply packs the pixels together more closely. That's why buying a 13-inch monitor for use as a 1024- by 768-pixel display doesn't make a lot of sense; the text and images will be too small to read easily. If you want to upgrade to a higher resolution, you need a bigger monitor to keep the image readable.—Raymond GA Côté

What's in a Name?

The March BYTE has a Microbytes item about the standard programming interface for electronic image processing, CLASP (Connecting Link for Applications and Source Peripherals). Because I am currently conducting a study about image acquisition and restitution, I am very interested in CLASP. However, I cannot find any information about it. Can you help me?

Michel Bories
Valbonne, France

Currently, there is no standard format for exchanging data between computers and peripherals that create or capture graphics images. Such a standard would make it far easier for programmers to write applications that would accept this graphical data rather than dealing with an alphabet soup of graphics image file formats (e.g., GIFF, TIFF, PCX, PICT, and BMP) on a variety of platforms.

CLASP's name has changed to TWAIN (Toolkit Without An Important Name). It provides a consistent, easy integration of image data between input devices and software applications. The specification has several goals. It must work with System 7.0 and Windows, but it should also be able to extend to Unix, OS/2, and other environments. It should support multiple devices, including handheld scanners, flatbed scanners, slide scanners, image-capture boards or frame grabbers, digital cameras, and image databases.

It should provide a well-defined interface that lets hardware and software developers provide drivers for their devices or include support through their applications. It should be extensible, and revisions should be backward-compatible with code written to earlier versions of the specification.

The interface and its documentation should be clear, well structured, well written, and intuitively designed. It should provide a single solution for the industry that will last for several years, or until such time as a facility like this might be supported at the operating-system level. This general data-interchange mechanism must be able to transmit data in existing standard formats and native file formats (e.g., TIFF, PICT, and DIB).

Several companies have got together to define TWAIN. The principal companies are Aldus, Caere, Eastman Kodak, Hewlett-Packard, and Logitech. Adobe, Howtek, and Software Architects are among the more than 160 other contributors. You can order the TWAIN programmer's toolkit and disk by calling the TWAIN distribution center at (800) 722-0379. You can send a fax to (303) 352-6152. Ask for document 9154. The cost is US$30.—Stan Wszola

VGA Interrupts

My Super VGA card (which uses a Tseng ET4000 chip set) has a jumper that lets me enable and disable IRQ2 (interrupt request). I have COM3 configured with IRQ2 and have the interrupt on the Super VGA card disabled. What exactly do I gain or lose by enabling or disabling IRQ2 on the Super VGA card, and would it be worth my time to reconfigure my COM port and enable the interrupt on my video card?

Gary Foster
Wichita, KS

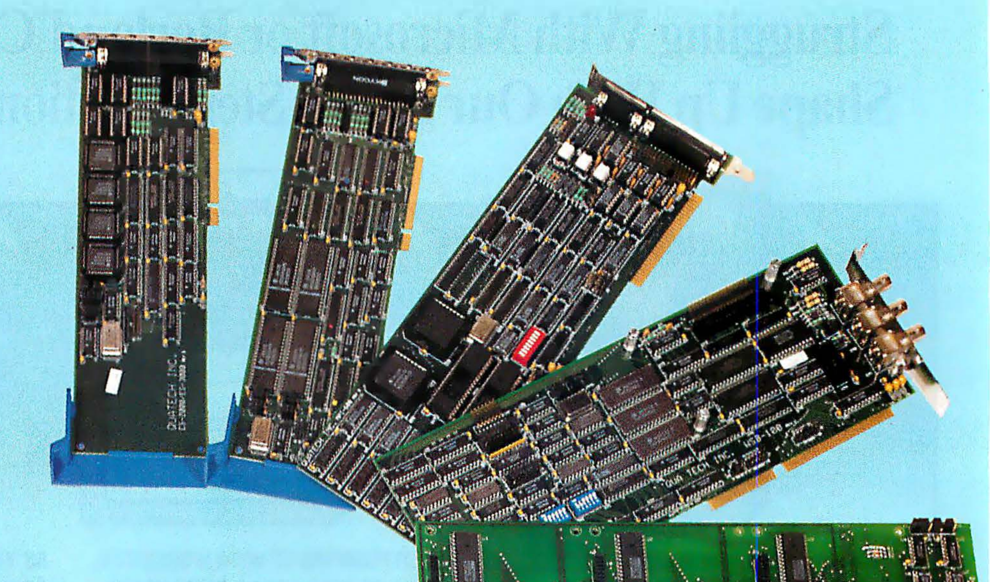
You are quite safe in leaving the interrupt disabled. The IRQ was originally introduced by IBM on the EGA video card. It triggers during every vertical retrace, thus letting you perform smooth animation by changing the screen contents while the data is not being drawn to the screen. Unfortunately, early IBM EGA adapters did not properly implement this interrupt. Because of that, there is little, if any, software that requires its presence.

—Raymond GA Côté ■

The BYTE Lab welcomes your questions. Address correspondence to Ask BYTE, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. You can also send BIX mail c/o "editors."

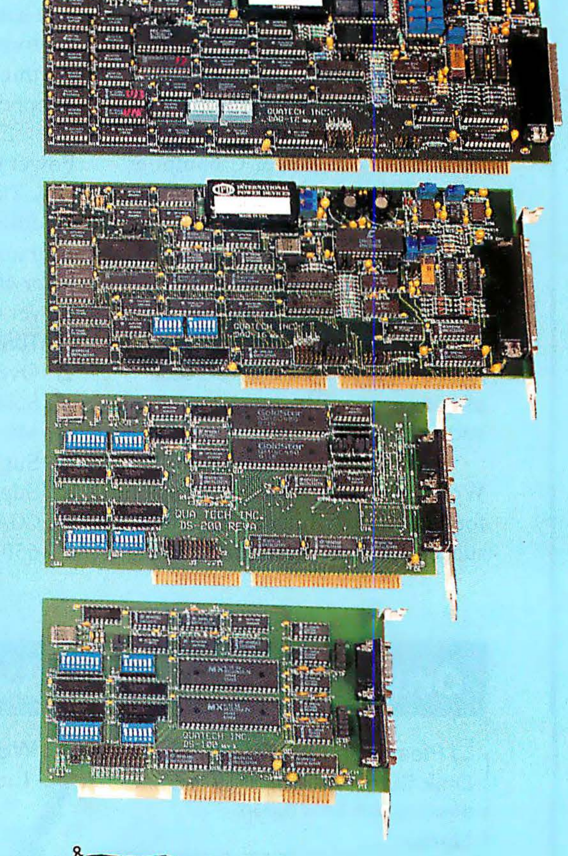
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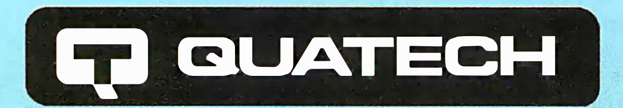


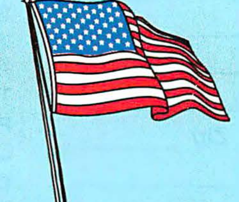
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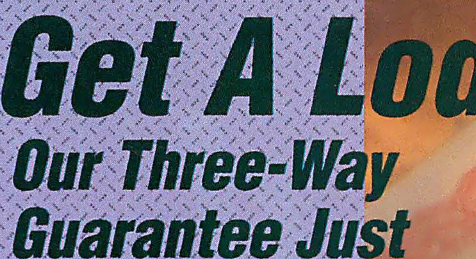
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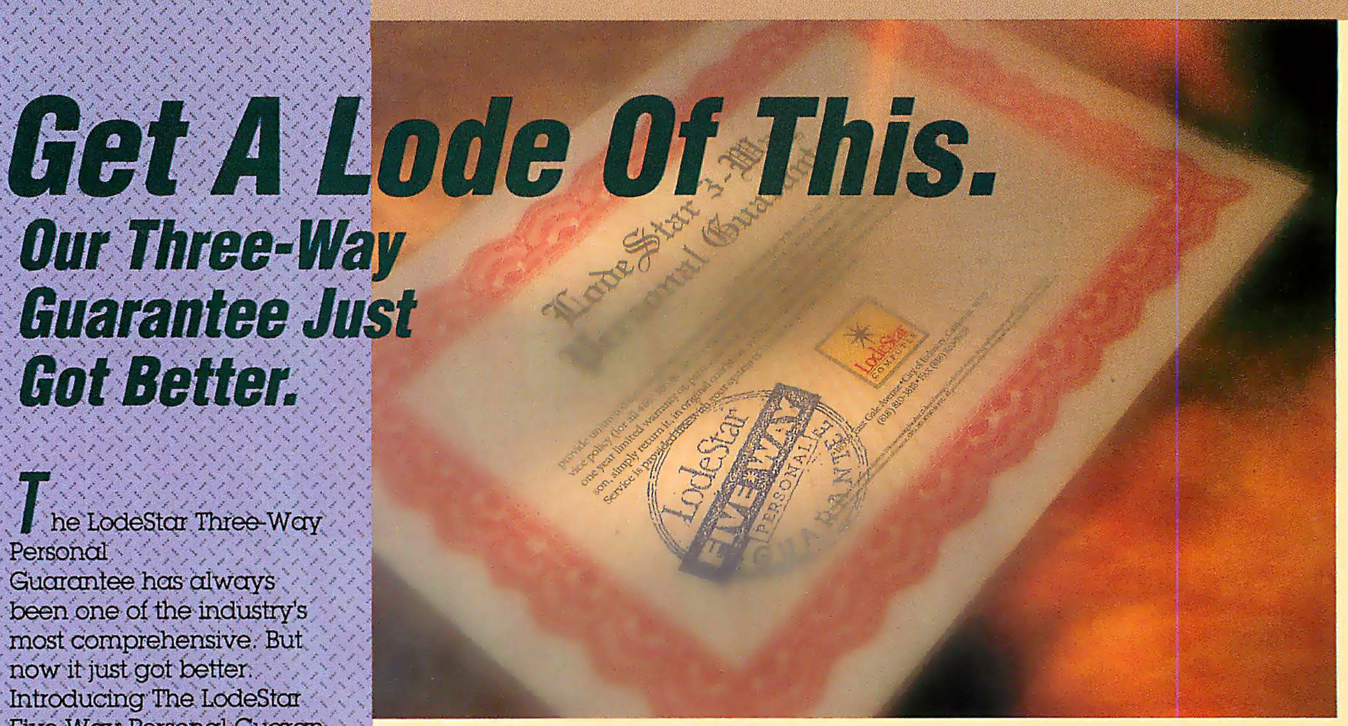
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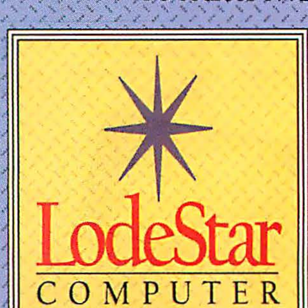
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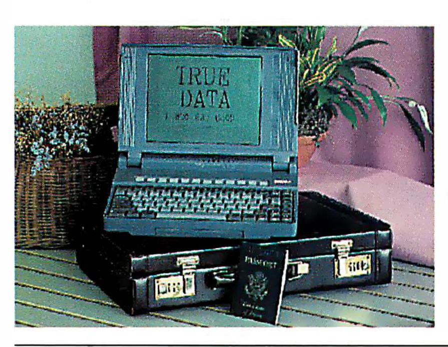


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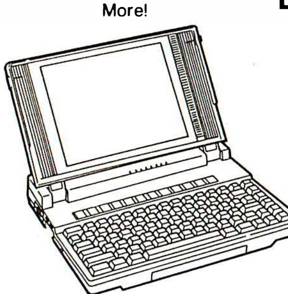
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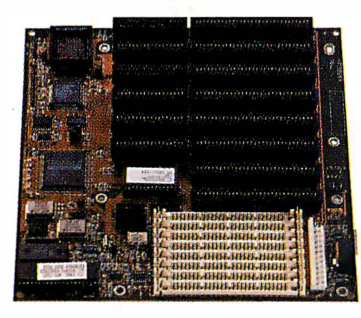
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* 486 DX-33	$599	NA	$779	$959	$1259	$1919
**486 DX-33 *Upgradable*	$675	NA	$855	$1035	$1335	$1995
**486 DX-33 *Local Bus Slot*	$685	NA	$865	$1045	$1345	$2005
**486 DX-50 *Upgradable*	$995	NA	$1191	$1387	$1695	$2395

*128k Cache Memory Standard **256k Cache Memory

Future Upgradability: 486 DX-33 to → DX-2/66 MHz
486 DX-50 to → DX-2/100 MHz

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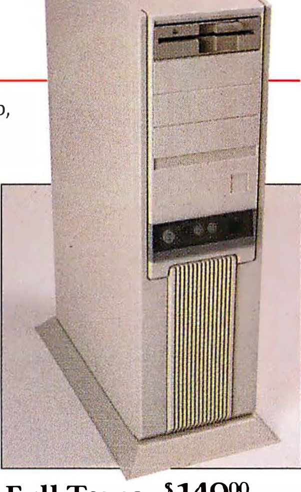
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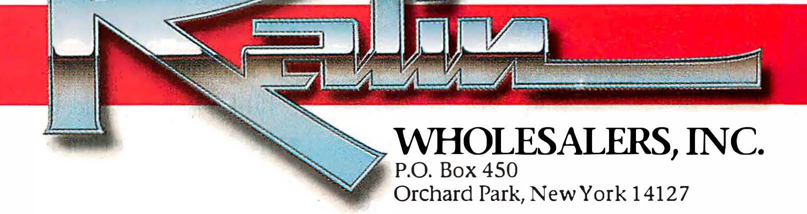
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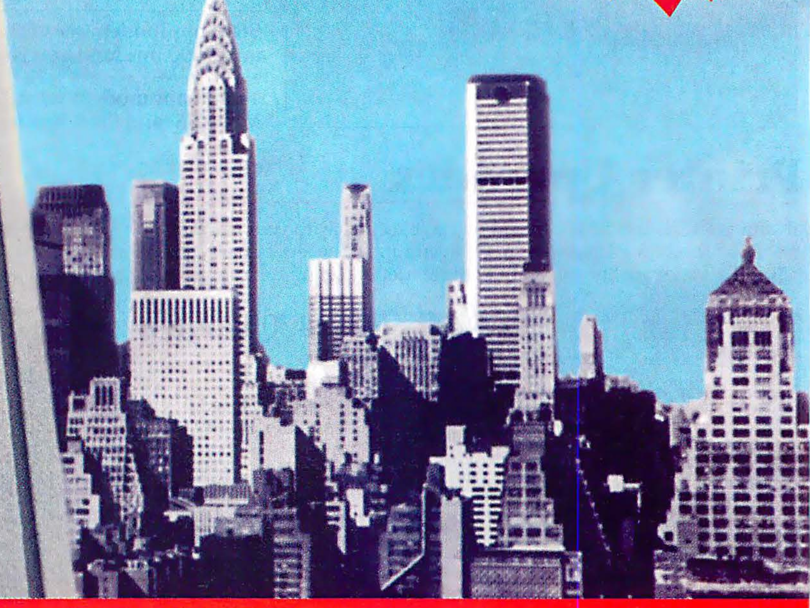
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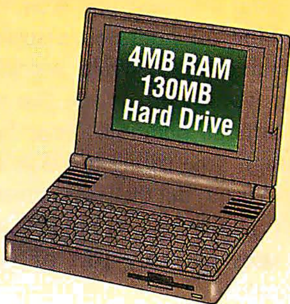
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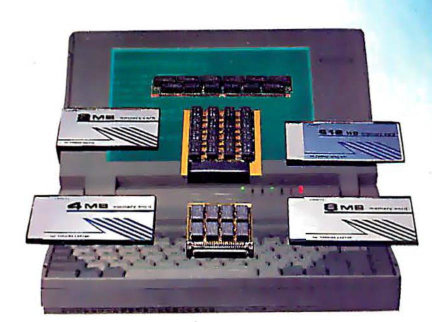
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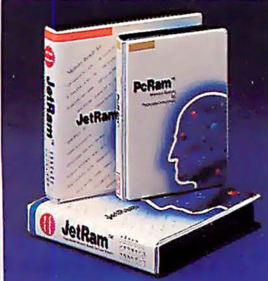
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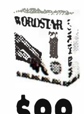
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All Hard Drives have a 1 Year Warranty

SYSTEMS

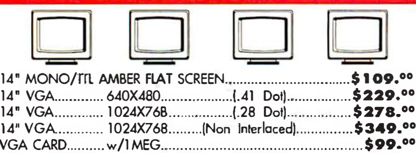
8088 XT 10MHZ W/640K MEMORY

Hard drive, 360K floppy, Par-Ser-Clock, 12" Amber Monitor, 101 Key Keyboard. 6 month warranty.

COMPLETE HARD DRIVE SYSTEMS:

30MB-$379 40MB-$399

MONITORS



14" MONO/TTL AMBER FLAT SCREEN			**$109.00**
14" VGA	640X480	(.41 Dot)	**$229.00**
14" VGA	1024X768	(.28 Dot)	**$278.00**
14" VGA	1024X768	(Non Interlaced)	**$349.00**
VGA CARD	w/1 MEG		**$99.00**

COPROCESSORS





8088BASED MACHINES:	80286BASED MACHINES:	80386BASED MACHINES:
8087-5MHz, **54.00**	80287-66MHz **39.00**	80387-16 16MHz **89.00**
8087-2 8MHz **79.00**	80287-88MHz **49.00**	80387-20 20MHz **94.00**
8087-1 10MHz **129.00**	80287-10 10MHz **89.00**	80387-25 25MHz **99.00**
	80287-XL **99.00**	80387-33 33MHz **109.00**
		80387-SX16 **89.00**
		80387-SX20 **99.00**
		80487-SX20 **539.00**

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150 WATT XT (DIRECT REPlACEMENT)	**39.00**
200 WATT AT (DIRECT REPLACEMENT)	**39.00**

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Hayes compatible; supports extended AT Command Set. Comm 1-4 & IRQ 3-5 & 7. On board speaker, software & telephone cord.

Internal $49 External $79

1200 baud internal $29

V.42 BIS MNP5 Hardware add $30

NEC MONITORS

NEC NEC NEC

NEC 3FGX	**$649.00**
NEC 4FG	**$749.00**
NEC 4D	**$799.00**
NEC 5FG	**$1379.00**

CONTROLLERS

IDEHD/Floppy **39.00**, 16BitHD&FLOPPY 1:1 **39.00**, 8 Bit HDonly **49.00** PCXTController **9.00** 16BitHardonly **19.00** **Super FLoppy**(controls fourdrives) 1.2, 360K, 720K & 1.44 **49.00**

FAXES

Send & receive 9600 BPS fax & 2400 BPS Modem. Hayes compatible. On board speaker. Mirror fax software. Port address Com 1-4. **$88**

14.4 Baud V.32 Bis Add $200

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WANGTEK Wangtec 5099EN24 drive, 6.5MB per minute, PC 36 Controller, Menu Driven Software, Easy installation, DC 600 cartridge. list $999.00 YOUR COST **$299**

3M DC 2000 (40MB) **13.00** DC 300XLP (45MB) **14.00** DC 6150 **22.00**

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MITSUBISHI EPSON **1 year warranty**

360K ½ HT 5¼ "	**$39**	1.2MB 5¼ "	**$58**
720K 3½ "	**$29**	1.44MB 3½ "	**$59**
		5¼ " Brackets	**$5**
		Compaq 360K	**$49**

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16 Bit. 2MB expandable to 4MB. (Uses 1MB x 1Dips) Works with IBM AT, 386 and compatibles. Expanded, Extended, 4.0 Lim compatible **2MEG $79 4MEG $159**

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MODEL	MEMORY ADDED	COMPAQ EQUIV. PART#	YOUR COST
DESKPRO 286	512K KIT	113012-001	**59.00**
DESKPRO 286N, 386N, 386SX/20 M SYSTEMS	1MB MODULE	118688-001	**59.00**
	2MB MODULE	118689-001	**99.00**
	OK BOARD	118700-001	**98.00**
	4MB MODULE	118690-001	**179.00**
	8MB	128877-001	**399.00**
DESKPRO 386/16	1MB-2MB BOARD	108069-001	**299.00**
	2MB BOARD	108069W71	**348.00**
	1MB KIT	108071-001	**114.00**
	4MB-8MB BOARD	108070-001	**545.00**
	4MB KIT	108072-001	**259.00**
DESKPRO 386S	1MB BOARD	113633-001	**109.00**
	4MB BOARD	113634-001	**239.00**
	1MB MODULE	113646-001	**75.00**
	4MB MODULE	112534-001	**209.00**
DESKPRO 386/20, 25, 286E	1MB MODULE	113131-001	**69.00**
	4MB MODULE	113132-001	**184.00**
	4MB BOARD	113190-001	**799.00**
DESKPRO 386/20E/25E	1MB BOARD	113644-001	**119.00**
	4MB BOARD	113645-001	**239.00**
DESKPRO 386/33, 486/25/33/33L	2MB MODULE	115144-001	**119.00**
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SYSTEMPRO	32MB MODULE	116568-001	**1850.00**
PORTABLE III	512K KIT	107331-001	**38.00**
	INTFC 8D	107808-001	**149.00**
	EXPBD	107811-001	**249.99**
	2MB KIT	107332-001	**119.00**
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	4MB MODULE	110237-001	**369.00**
LTE	512K KIT	117077-001	**149.00**
LTE/386S20	1MB	121125-001	**99.00**
	4MB	121125-002	**249.00**
LTE/286	1MB BOARD	117081-001	**69.00**
	4MB BOARD	117081-003	**299.00**
PORTABLE 386	1MB KIT	107651-001	**149.00**
	INTFC BD	107707-001	**129.00**
	4MB BOARD	107653-001	**469.00**
	4MB EXT BRD	107654-001	**469.00**
SLT/386S	1MB MODULE	118303-001	**89.00**
	2MB MODULE	118304-001	**139.00**
	4MB MODULE	118305-001	**249.00**
LITE 20&25	2MEG	129769-001	**189.99**
	4MEG	129769-002	**319.00**
	8MEG	129769-003	**695.00**

In Touch with Tomorrow TOSHIBA MEMORY

TOSHIBA MODEL	MEMORY ADDED	TOSHIBA EQUIV. PART #	YOUR COST
T1000SE & XE/LE	1MEG	PC14-PA8311U	**119.00**
T1000SE & XE/LE	2MEG	PC14-PA8312U	**169.00**
T2000SX/T2000	1MEG	PC18-PA8316U	**89.00**
T2000SX/T2000	2MEG	PC18-PA8317U	**119.00**
T2000SX/T1000LE	4MEG	PC-PA8314U	**219.00**
T2000SX/T1000LE	BMEG	PC-PA8315U	**399.00**
T2000SXE/2200SX	2MEG	PC-PA2000U	**119.00**
T2000SXE/2200SX	4MEG	PC-PA2001U	**219.00**
T2000SXE/2200SX	BMEG	PC-PA2002U	**399.00**
T1200XE	2MEG	PC13-PA8306U	**99.00**
T1600	2MEG	PC8-PA8302U	**99.00**
T3100E	2MEG	PC9-PA8341U	**99.00**
T3100SX	2MEG	PC15-PA8308U	**99.00**
T3100SX	4MEG	PC15-PA8310U	**174.00**
T3200	3MEG	PC6-PA7137U	**159.00**
T3200SX	2MEG	PC12-PA8307U	**104.00**
T3200SX	4MEG	PC12-PA8309U	**174.00**
T3200SXC	2MEG	PC19-PA8318U	**109.00**
T3200SXC	4MEG	PC19-PA8319U	**184.00**
T4400SX, T6400 & C	2MEG	PC-PA2003U	**199.00**
T4400SX, T6400 & C	4MEG	PC-PA2004U	**399.00**
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T5100	2MEG	PC7-PA8301U	**99.00**
T8500 or	2MEG	PC10-PA8304U	**109.00**
T5200 & T5200C	BMEG	PC10-PA8313U	**369.00**

IBM PS/2 MEMORY

IBM PS/2 MODEL#	MEMORY ADDED	IBM EQUIV. PART#	YOUR COST
PS/1, 386SX	2MB	92F9935	**119.00**
30-286	512KKIT	30F5348	**38.00**
	2MBKIT	30F5360	**94.00**
L40SX&N33SXLAPTOP	2MEG	79F0999	**89.00**
	4MEG	79F1000	**159.00**
	8MEG	79F1001	**339.00**
50Z&55SX,65SX	1MBSIMM	6450603	**59.00**
	2MBSIMM	6450604	**85.00**
40SX, 55SX, 65SX, 35SX, 35LS	4MBMODULE	34F2933/87F9977	**159.00**
50,50Z,55SX&60,65SX	2-8MBBOARD	1497259/6450609	**349.00**
35SX,LS,40SX	1MBSIMM	6450603	**59.00**
70-E61,061,121,P70	2MB SIMM	6450604	**85.00**
70-A21 A61,B21,B61	2MBSIMM	6450608	**94.00**
80-041	1MBMODULE	6450375	**98.00**
80-111, 121, 311, 321	2MBMODULE	6450379	**109.00**
80-A21,A31	4MBMODULE	6451060	**199.00**
35SX:LS&40SX	8MB	6450129	**359.00**
All70s&80s	2-8MB BOARD	6450605	**299.00**
	2-14MBBOARD	34F3077	**358.00**
	4-16MBBOARD	34F3011	**488.00**
57SX, 90, 95,P75	2MB	6450902	**99.00**
	4MB	6450128	**169.00**
	8MB	6450130	**359.00**

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	1MEG	2MEG	4MEG
HP2, 2D, 3, 3D, 3P, 2P, 2P+		109	169
HP III SI	59		179
IBMLASER4019, 4019E	89	135	189
IBMLASER4029			189
PANASONIC 4410/4430	129	209	319
PANASONIC 4420/4450I	89	129	209
PANASONIC 4450	119		
PANASONIC 4455		134	
NEC 90, 290		134	
QMS410	114	154	244
TIXL/PS17/PS35	59		
CANONLBP4	154	214	
STARLS04	129	179	269
EPSON 6000, ACTION LSR.		125	189
TOSHIBA PAGELASER6		125	199
PACKARDBELLPB9500		125	199
OKI 400	99	149	

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256X8	**3.00**	**4.00**	**6.00**	**8.00**	**14.00**	
256X9		**9.00**	**14.00**	**17.00**	**26.00**	**29.00**
1MEG X 9			**33.00**	**36.00**	**38.00**	**41.00**
4MEG X 9				**124.00**	**134.00**	**154.00**
512X36 2MEG (72PIN)				**99.00**		
1X36 4MEG (72PIN)				**169.00**		
2X36 8MEG (72PIN)				**359.00**		
4X36 16MEG (72PIN)				**649.00**		

RAM CHIPS (DIPS)

DESCRIPTION	150NS	120NS	100NS	80NS	70NS	60NS
64X4	**1.95**	**2.25**	**2.45**	**2.95**		
256X1 STATIC				**1.95**	**2.25**	
256X1	**.95**	**1.05**	**1.10**	**1.15**	**1.45**	**2.20**
256X4		**3.95**	**4.45**	**4.95**	**5.45**	**5.95**
1MEGX1		**3.50**	**3.85**	**4.10**	**4.45**	**4.95**
1MEGX1 STATIC				**4.95**	**5.25**	
1MEGX4				**22.00**		

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COMBO-MONO $99
12" Monographics Monitor with controller card.

COMBO-VGA $289
640 x 480 VGA monitor with controller card and 256K video RAM. Works with AT or 386 computers.

COMBO-SVGA $439
1024 x 768 Super VGA monitor with controller card and 1 MEG video RAM.



HARD DRIVE COMBO'S

Now's the time to upgrade your computer system with our hard drive combo's. Change your outdated MFM drive to a faster more reliable IDE hard drive. Works with AT, 386 and 486 computers.

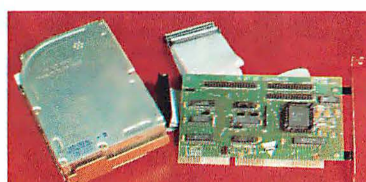
COMBO-40 $225
40 MEG IDE 28ms hard drive with controller card.

COMBO-105 $335
105 MEG IDE 15ms hard drive with controller card.

COMBO-130 $375
120 MEG IDE 19ms hard drive with controller card.

COMBO-210 $649
210 MEG IDE 15ms hard drive with controller card.

GREAT NEW PRICES!



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DC2060T-3M	Thetamat for Colo. Mem.	22.99
DC2080R-3M	Rhomat for Irwin 80	15.99
DC2120-3M	120 Megabyte	18.49
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DC6250-3M	250 Megabyte	24.99
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3M DISKETTES

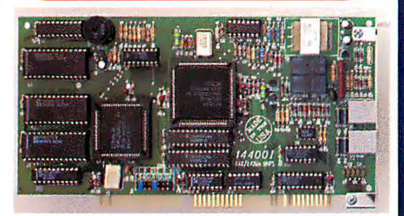
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3.5DSHD	DSHD	13.39
3.5DSHD/F	DSHD Formatted	13.99

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Part#	Description	Per Box/10
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5.25DS/F	DSDD Formatted	5.39
5.25DSHD	DSHD	8.49
5.25DSHD/F	DSHD Formatted	9.19

BOCA 14.4K MODEM



M14401 BOCA V.32BIS, 14.4K Modem Internal **$239**
M1440E BOCA V.32 BIS, 14.4K Modem External **$319**
BOCA Research FAX Send/Receive Modem. Uses Rockwell chip set, transmits and receives FAXES up to 9600 BAUD. Modem transmits and receives data up to 14.4K BAUD. Includes Quicklink II Software. Made in the U.S.A. and comes with BOCA 5-year warranty.

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AMC-2400	Internal 2400 BAUD Modem	$59
AMX-2400	External 2400 BAUD Modem	$69

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RM9502	14" Monochrome VGA Monitor (800 x 350, 400, 480)	$139
RE1420	14" Super VGA Monitor (1024 x 768) Unlimited Colors - 2-year manufacturers' warranty	$359
MON-05	Monochrome TTL Amber (720 x 348) 12"	$89
MON-06	Paper White TTL 14"	$112
MON-10	CGA/RGB (640x240) 14"	$219
MON-07	VGA .41 Dot Pitch 640 x 480 14" - One-year manufacturers' warranty	$239

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3C87-16SX	For 386SX up to 16 MHz	72
3C87-20SX	For 386SX up to 20 MHz	72
3C87-25SX	For 386SX up to 25 MHz	75
3C87-25 .	For 386 up to 25 MHz	92
3C87-33	For 386 up to 33 MHz	95
3C87-40	For 386 up to 40 MHz	123

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256KX9-80	256K x 9-80 NS SIMM	$13.00
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256KX9-70	256K x 9-70 NS SIMM	14.00
1MEGX9-80	1MB x 9-80 NS SIMM	44.00
1MEGX9-80SP	1MB x 9-80 NS SIPP	46.00
1MEGX9-70	1MB x 9-70 NS SIMM	46.00
1MEGX9-70SP	1MB x 9-70 NS SIPP	48.00
1MEGX9-60	1MB x 9-60 NS SIMM	48.00
4MEGX9-60	4MB x 60 NS SIMM	Call

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Part#	Each
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BC-400	$169
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BC-500LAN	$199
BC-600LAN	$269
BC-900LAN	$379
BC-1250LAN	$529
BC-4000LAN	$2549

OMNI Back-Up Systems

Part#	Each
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OMNI-600LAN	$399
OMNI-900LAN	$549
OMNI-1250LAN	$679
OMNI-2000LAN	$1149

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UL listed and 2 year warranty.

Part#	Description	Each
LS-504	500 Watts, 230 Volt, 4 Outlets	$98
LS-600	600 Watts, 2 Outlets	77
LS-604	LS-600 with HI voltage regulation	98
LC-1200	1200 Watts, 4 Outlets	139
LC-1800	1800 Watts, 6 Outlets	188
LC-2000	2000 Watts, 208/220/240 Volt	243
LC-2000X	220/240 V, 2000 watts,6 Outlets	243
LC-2400	2400 watts,110 V, 6 outlets	243
LCR-2400	2400 watt rack mt., 110 V, 14 outlets	287

Modem Fax Protectors

2 year warranty.

Part#	Description	Each
ISOTEL	Lifetime warranty. 4 outlet, 6 ft. cord and modem protector (*Gold Seal)	$59
ISOFAX	ISOBLOK w/ Modem protector	36
TSB	3 stage Modem/Fax protector	38
MP	Economy Modem/Fax protector	14
SMP	1 AC outlet w/modem/fax protector	29
SMP-GS	Lifetime guarantee. (*Gold Seal)	35

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All Isobars come with a lifetime warranty and UL listing.

Part#	Description	Each
IB2-0	2 outlet direct plug-in	$23
IB2-0/20	2 outlet, 20 amp, direct plug-in	39
IB2-6	2 outlet, 6 ft. cord (*Gold Seal)	32
IB4	4 outlet, 6 ft. cord (*Gold Seal)	43
IB4/220	4 outlet, 6 ft. cord, 220 Volt	49
IB6	6 outlet, 6 ft. cord (*Gold Seal)	51
IB8	8 outlet, 12 ft. cord (*Gold Seal)	61
IB-8RM	8 outlet, 12 ft. cord w/remote power switch	69
EUROBAR	4 outlet, 6 ft. cord, 220/240 Volt Euro connectors	52
IBR-12	12 outlet, 19" rack mountable	89

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DDD-04	5 1/4 inch DSDD 360K black faceplate	$59
DDD-05	5 1/4 inch DSDD 360K beige faceplate	59
DDH-06	5 1/4 inch DSHD 1.2MB beige faceplate	59
DDH-09	3 1/2 inch 720K beige w/bracket	59
DDH-10	3 1/2 inch 1.44MB beige w/bracket	59
DDH-11	Same as DDH-10 without 5-1/4" Mounting bracket. Fits in 3-1/2" bay	55

3-1/2" Drive Mounting Kits $9.95

5.25KITFD Mounts 3-1/2" Floppy drive in 5-1/4" Bay
5.25KITHD Mounts 3-1/2" Hard drive in 5-1/4" Bay

HARD DRIVES

ST-351A	40MB, 28MS IDE, 3-1/2"	$209
ST-3120A	105MB, 15MS IDE, 3-1/2"	$319
ST-3144A	120MB, 19MS IDE, 3-1/2"	$359
ST-1239A	210MB, 15MS IDE, 3-1/2"	$639

SCSI Hard Drives

ST-1239N	Seagate 204MEG, SCSI, 15MS,3-1/2"	$649
ST1480N	Seagate 426MEG, SCSI, 14MS,3-1/2"	$1399
ST-41650N	Seagate 1.4GB, SCSI, 15MS, FH	$2479

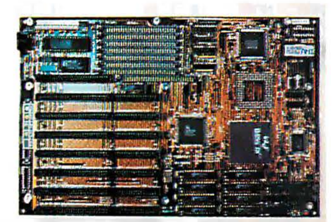
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ST-251	40MEG Fixed Disk without Controller ST-251, 5-1/4"	$259

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MOTHERBOARDS



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MB386SX-25	25MHz 286 Motherboard	$159
MB386-33C	33MHz 386 Motherboard	$299
MB486-33	33MHz 486 Motherboard	$659

Descriptions and Prices on Mother Boards Subject to Change.

EXPANSION BOARDS

Part#	Description	Each
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IFC-25	2 Serial, Parallel, Game Board XT/AT	$16
IFC-13	Parallel Board XT/AT	$9
IFC-20	Game Board XT/AT 2 Ports	$9
IFC-70	BOCA 2 Serial, 2 Parallel I/O Board	$49

DISK CONTROLLER BOARDS

Part#	Description	Each
IFC-14	2 Floppy Controller Board PC/XT	$13
IFC-15	Disk I/O Board Serial, Parallel, Clock, Game PC/XT	$25
IFC-24	Fixed Disk MFM/ 2 Floppy Controller AT	$69
IFC-27-2	AT 2/IDE 2/Floppy Controller	$19
IFC-28	Fixed Disk Controller Board PC/XT XT MFM hard drive controller board.	$47
ST-01	8-Bit SCSI Controller Board	$29
ST-02	8-Bit SCSI/Floppy Controller Board	$47
IN-2000	16-Bit SCSI Hard/Floppy Controller Board	$189

POWER SUPPLIES

Part#	Description	Each
PS-150	150 watt XT Power Supply	$39
PS-200M	200 watt XT power Supply	49
PS-200	200 watt AT Power Supply	59
PS-230	230 watt Large Vertical Case	79
PS-200MINI	200 watt Baby Vertical Case	59

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AT style, 10 function keys. XT or AT

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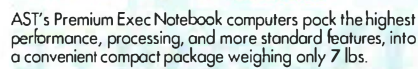
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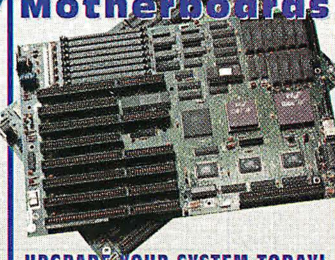
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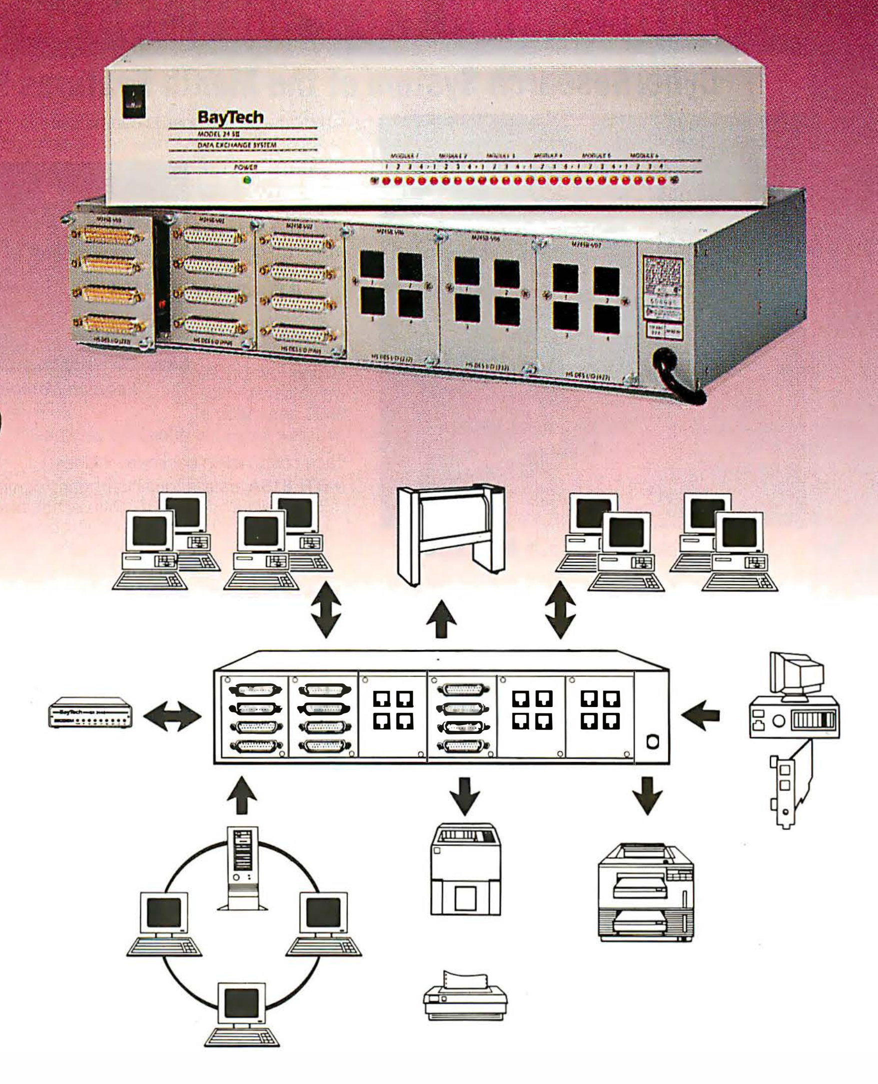
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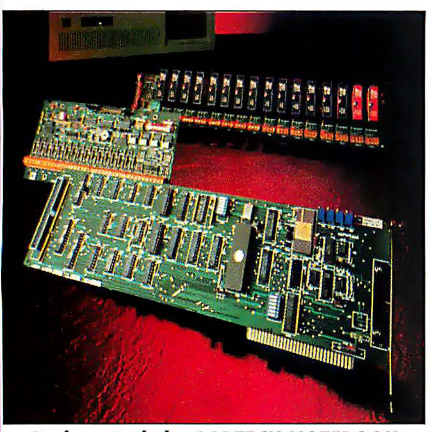
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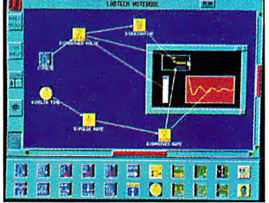
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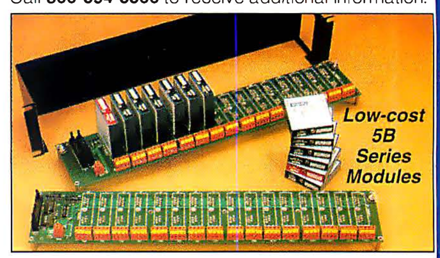
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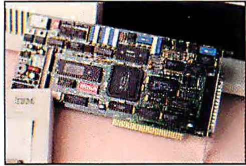
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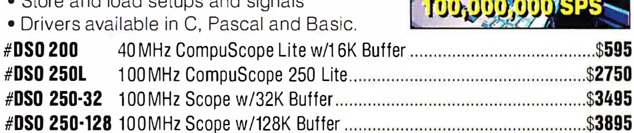
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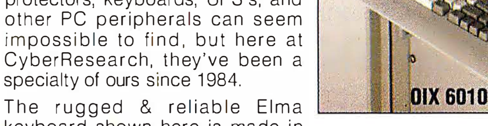


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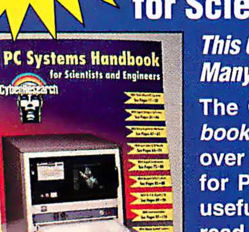


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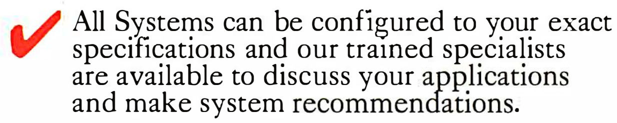
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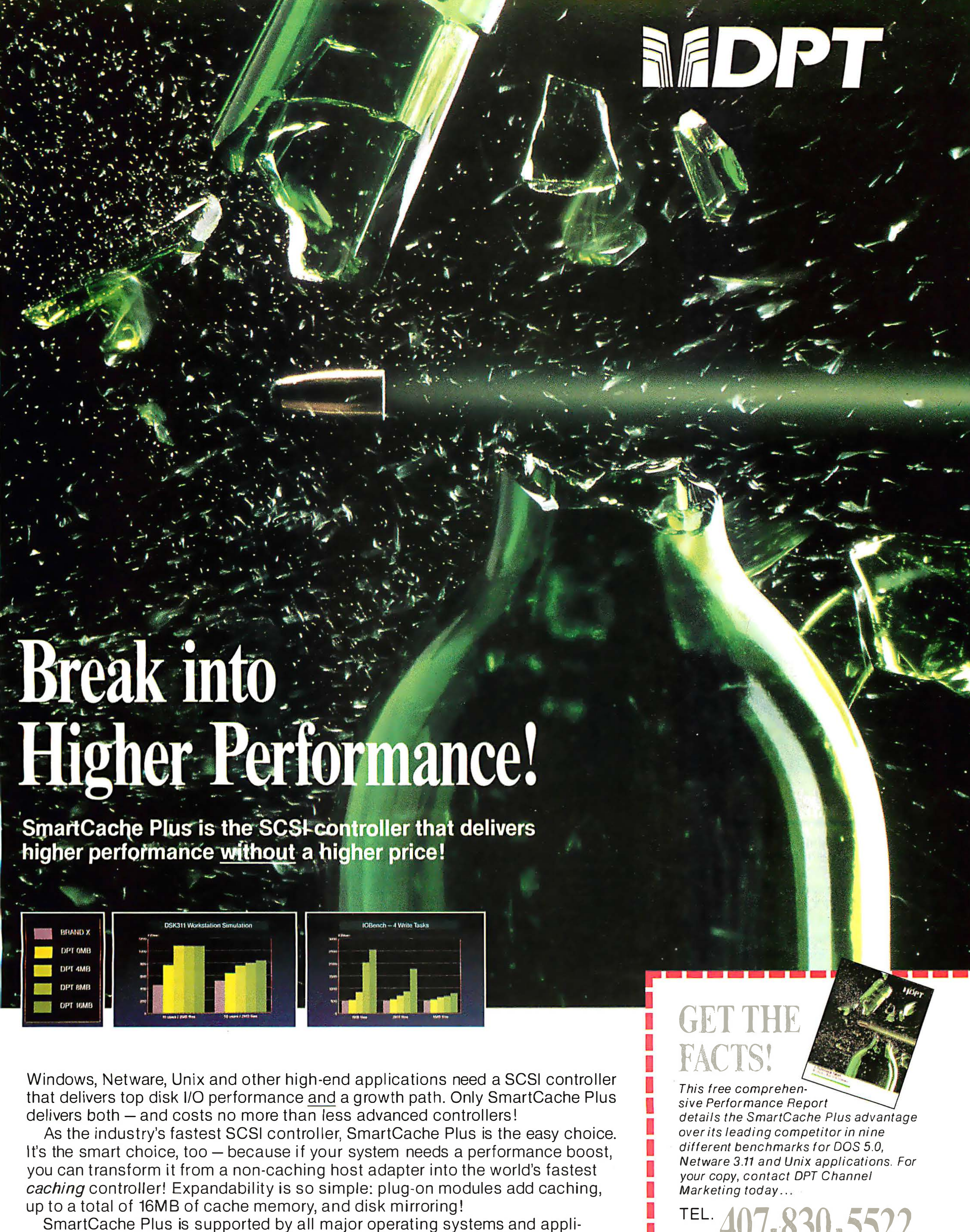
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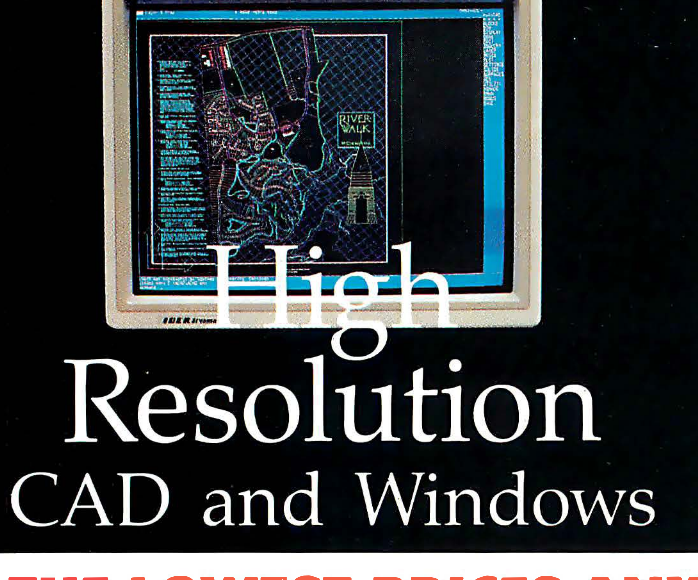
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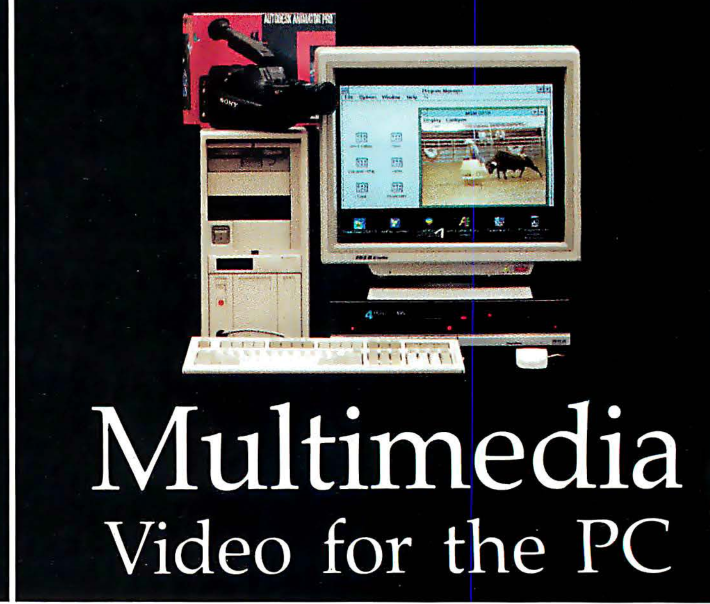
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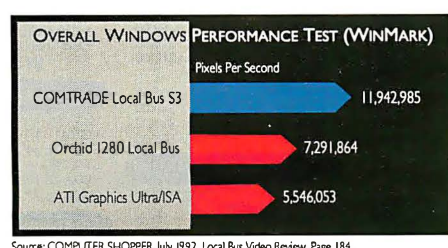
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Source: COMPUTER SHOPPER, July 1992, Local Bus Video Review, Page 184.



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IBM MEMORY

LASER PRINTER MODEL 4019, 4019E	1MBBOARD	1039136	$ 83
	2MBBOARD	1039137	140
	3.5MBBOARD	1038675	225
LASER PRINTER MODEL 4029	1MBBOARD	118333	115
	2MBBOARD	118334	185
	4MBBOARD	116335	290
PS/1 & 386SX	512K MODULE	1057035	70
	2MBMODULE	92F9935	170
	4MBMODULE	92F9694	320
PS/2 25	128KKIT	78X8955	28
PS/2 25/286 30-286	512KKIT	30F5348	45
	2MBKIT	30F5360	115
ABOVE INSTALLED ON EXPANSION BOARD 1497259 FOR 50, 50z & 60			
35SX, LS, 40SX PS/2 50Z, 55SX, 65SX 55LS, 65LS	2MB SIMM	6450604, 90X8625	100
35SX, LS, 40SX 55SX, 65SX 55LS, & 65LS	4MB MODULE	34F2933or 87F9977	195
ABOVE INSTALLED ON SYSTEM BOARD			
(UPGRADES W/6450603 6450640&34F2933	1-13MB BOARD	6450685	180
	2-14MB BOARD	6450609	290
	4-16MB BOARD	6450609	350
PS/2 70-E61,061,121,P70	1MB SIMM	6450603	60
	2MB SIMM	6450604 90X9525	100
PS/2 70-A21,A61 B21 & B61	2MB SIMM	6450608	105
PS/2 80-041	1MB MODULE	6450375	88
PS80-81,111,121 161,311 & 321	2MB MODULE	6450379	120
PS/2 80-A21, A31, A61	4MB MODULE	6451060	255
PS/2 90, 95 & P75 (INSTALL IN PAIRS)	2MBSIMM	6450902	130
	4BMSIMM	6450128	220
PS/2 ALL 70s & 80s	2-8MBBOARD	6450605	220
(UPGRADES W/STD SIMMS)	4-8MBBOARD	34F3011	400
	8MBBOARD		550
PS/2 ALL 70s & 80s	2-14MBBOARD	34F3077	270
	4-16MBBOARD	34F3011	380
	8-16MBBOARD		620
	16MBBOARD		940
34F3077 IS INTERCHANGABLE WITH 6450605			
RISC 6000 (NO BOARD INCLUDED)	16MB KIT	4010	1,100
	32MB KIT	4033	2,400
	64BM KIT	4036	4,500
L40SX & N335SX LAPTOP	2MB SIMM	79F0999	165
	4MB SIMM	79F1000	340
	8MB SIMM	79F1001	600
*35SX, LS & 40SX	8MB SIMM	6450129	470
*50SX, 90 & 95	8MB SIMM	6450130	490

COMPAQ MEMORY

DESKPRO 286	512KKIT	113012-001	$ 45
DESKPRO 286E	1MB MODULE	113131-001	65
	4MBMODULE	113132-001	225
DESKPRO 286N, 386N	EXPBOARD	118700-001	90
DESKPROP 286N, 386N 286SX/20, 386/25M, 486/33M, 486S/25M, 486S/16M	1MB SIMM	118688-001	70
	2MB SIMM	118689-001	110
	4MB SIMM	118690-001	210
	8MB SIMM	128877-001	460
SYSTEMPRO LT 486SX/25S, 386/25S, PORTABLE 486C NOTE: 8MB SIMM FORM, SYSTEMPRO & PORTABLE SERIES ONLY.			
DESKPRO 386/16	1MBBOARD	108069-001	210
	2MBBOARD	108089W71	290
	1MBKIT	108071-001	70
	4MBBOARD	108070-001	440
	8MBBOARD	108070 W/72KIT	675
	4MBKIT	108072-001	215
DESKPRO 386S	1MBBOARD	113633-001	145
	4MBBOARD	113634-001	275
	1MB MODULE	113646-001	75
	4MB MODULE	112534-001	230
DESKPRO 386/20, 20E 25 & 25E	1MBBOARD	113644-001	145
	4MBBOARD	113645-001	275
	1MB MODULE	113131-001	75
	4MB MODULE	113132-001	230
DESKPRO 386/33L 486/25, 33, 33L SYSTEMPRO	6SOCKETBD	115569-001	315
	2MB MODULE	115144-001	130
	8MBMODULE	116561-001	480
	32MB MODULE	116568-001	2,700
DESKPRO 486/33M, 486/25M, 16M, 386/25M, SYSTEM PRO LT, 486SX/25S, 386/25S	8 SOCKET BD	129160-001	299

PORTABLE III	512KKIT	107331-001	35
	INTERFACEBD	107808-001	85
	EXPANSIONBD	107811-001	210
	2MBKIT	107332-001	105
SLT/286	1MB MODULE	110235-001	95
	4MBMODULE	110237-001	395
LTE LTE/286	512K MODULE	117077-001	105
	1MB MODULE	117081-001	90
	2MB MODULE	117081-002	125
	4MBMODULE	117081-003	320
LTE/386S/20	1MBCARD	121125-001	170
	4MBCARD	121125-002	400
PORTABLE 386	1MBKIT	107651-001	$115
	INTERFACEBD	107707-001	100
	4MBBOARD	107653-001	375
	4MBEXTENDBD	107654-001	375
SLT/386S	1MBMODULE	118303-001	115
	2MBMODULE	118304-001	165
	4MBMODULE	118305-001	320

TOSHIBA MEMORY

PORTABLE T1000SE & XE.LE	1MBCARD	PC-PA8311U	$ 109
	2MBCARD	PC-PA8312U	160
PORTABLE T2000SX & T2000	1MB CARD	PC18-PA8316U	109
	2MB CARD	PC18-PA8317U	160
PORTABLE T2000, T2000SX & T1000LE	4MB CARD	PC1X-PA8314U	340
	8MB CARD	PC1X-PA8315U	740
*PORTABLE T2000SXE & T2200SX	2MB CARDB	PC-PA2000U	185
	4MB CARD	PC-PA20001U	395
	8MBCARD	PC-PA20002U	800
PORTABLE T1200XE	2MB MODULE	PC13-PA8306U	115
PORTABLE T1600	2MBMODULE	PC8-PA8302U	115
PORTABLE T3100E	512K KIT	PC9-PA8340U	99
	2mb KIT	PC9-PA8341U	115
PORTABLE T3100SX	2MBMODULE	PC15-PA8308U	115
	4MBMODULE	PC15-PA8310U	215
PORTABLE 3200	3MBMODULE	PC6-PA7137U	190
PORTABLE T3200SX	2MBKIT	PC12-PA8307U	115
	4MB KIT	PC12-PA8309U	215
PORTABLE T3200SXC	2MBKIT	PC19-PA8318U	125
	4MB KIT	PC19-PA9319U	225
T4400SX	2MBCARD	PC-PA2003U	220
	4MBCARD	PC-PA2004U	360
	8MBCARD	PC-PA2005U	695
PORTABLE T5100 T5100C	2MBMODULE	PC7-PA8301U	120
PORTABLE T5200C DESKTOP-T8500	2MBKIT	PCX-PA8304U	115
	8MBKIT	PCX-PA8313U	475

AST MEMORY

BRAVO286	128KKIT	500510-011	$ 25
	512KKIT	500510-010	35
	2MBKIT	500510-002	105
	4MBKIT	500510-008	205
BRAVO386SX/20	512KKIT	500510-012	42
	2MBKIT	500710-003	110
	8MBKIT	500824-001	395
BRAVO386SX	2MBKIT	500510-002	110
	4MBKIT	500510-008	205
BRAVO486/25	2MBKIT	500718-004	120
	8MBKIT	500780-001	465
PREMIUM 286 FASTRAM	512KKIT	500510-001	40
ADV-FASTRAM	1MBKIT	500510-007	60
PREMIUM WKST286, 386SX	512KKIT	500510-010	35
	1MBKIT	500510-007	60
	2MBKIT	500510-002	105
	4MBKIT	500510-008	205
FASTBOARD386	1MBKIT	500510-007	60
PREMIUM386/16C	4MBKIT	500510-008	205
PREMIUM WKST/286	512KKIT	500510-010	35
	2MBKIT	500510-002	105
PREMIUM 386	1MBKIT	500510-003	65
	4MBKIT	500510-004	245
PREMIUM 386/20 386/16SX	1MB SIMM	500718-001	55
	1MB SIMM	500718-002	60
CUPID.32 PREMIUM SERIES 386DESKTOP 16SX, 25, 33	1MBSIMM	500780-003	55
	4MBSIMM	500780-004	205
	8MBKIT	500780-001	360
	CUPIDBD	500818-001	295
PREMIUM II DESKTOP 386SX20 486DESKTOP-25, 25E, 33 PREMIUM TOWER 386/33TE, 486/25TE, 486/33TE PROCESSOR CARD FOR 25 & 33			
PREMIUM EXEC 386SX, 286	1MB SIMM	500814-001*	70
	4MB SIMM	500814-003*	185
NOTEBOOK 500814-001 FOR PREMIUM EXEC 286/12 ONLY			
386SX/25, 25C	1MB SIMM	N/A	90
	4MB SIMM	500814-004	200

APPLE MEMORY

POWERBOOK100	2MBMDL	M1032LL/A	$300
	4MBMDL	M1031LL/A	395
	6MBMDL	N/A	550
POWERBOOK 140/170	2MB MDL	N/A	300
	4MBMDL	M1033LL/A	395
	6MBMDL	N/A	550
QUADRA700	4MBKIT	M0292LL/A	180
	16MBKIT	N/A	640
	64MBKIT	N/A	3,500
QUADRA900	4MBKIT	M0292LL/A	180
	16MBKIT	N/A	640
	64MBKIT	N/A	3,000
IISI	2MBSIMM	M0514LL/A	95
	8MBKIT	M0513LL/A	350
MACLC	4MB KIT	N/A	$195
	8MBKIT	N/A	360
	512KSIMM	M0517LL/A	109
MACIICI, IISI	1MBKIT	M0291LL/A	55
	4MBKIT	M0292LL/A	170
	16MBKIT	N/A	650
CLASSIC	1-3MBBD	M6361LL/A	75
	2MBKIT	M0219	90
MACPORTABLE	2MBBD	N/A	550
	4MBBBD	N/A	750
MACII, IIX, IICX & SE/30	1MBKIT	M0218	60
	2MBKIT	M0219	85
	4MBKIT	M0707	180
	16MBKIT	N/A	700
MACIIFX	4MBKIT	M0376LL/A	185
	16MBKIT	N/A	650
LASER WRITER E II NTX-J II F & II G	1MBKIT	M6005	75
	4MBKIT	M6006	185
	16MBKIT	N/A	650
MACIIVIDEO	KIT	M0213	90
MAXIMA	SOFTWARE	N/A	75

ALR MEMORY

VENTURA NOTEBOOK 16 & 20	1MB MODULE	12407970	$225
	4MBMODULE	12407380	1,090
POWERFLEX & 20CSX	1MB KIT	12901000	70
	2MBKIT	12902000	105
	4MB KIT	12904000	210
	16MBKIT	N/A	785
POWERPRO	4MBKIT	12904000	210
	16MBKIT	12916000	750
POWERCACHE 486 & 486E	2MBKIT	12902000	110
	8MBKIT	12904000	395
	32MB KIT	12916000	1,400
BUSINESS/ POWERVEISA	1MBKIT	12901000	70
	4MBKIT	12904000	205
	16MB KIT	12916000	805
1-32MB EXPBD		12427480	261
	4-32MBEXPBD	12447480	532
	8-32MBEXPBD	12467480	732
	16-32MBEXPBD	12487480	1,105

DELL MEMORY

450/SE DE, 420/SE DE, 433TE SE DE & 425TE SE DE	2MBKIT	310-2466	$110
	4MBKIT	310-2467	230
	8MBKIT	310-2468	420
	16MBKIT	310-2469	790
	32MBKIT	N/A	1,750
433E & 425E	2MBKIT	310-2389	110
	4MBKIT	310-2390	230
	8MBKIT	N/A	420
320N & 212N	1MB SIMM	310-3203	165
	2MBSIMM	310-3204	295
320LT & 316LT	2MBKIT	310-2494	105
	4MBKIT	310-2494	210
	8MBKIT	310-2494	420
325P/D & 333P/D	1MBMODULE	310-2505	65
	4MB MODULE	310-2507	220
325, 310, 320LS, 316 316SX & 210	1MBKIT	310-2104	70
	4MBKIT	310-2273	220

EPSON MEMORY

NBS3	1MBMODULE	A808501	$130
	4MBMODULE	A808511	365
EQUITY LT 286E	1MBMODULE	A908191	116
EQUITY LT 386SX	2MB MODULE	A508361	225
EQUITY IIE 386/25, 20	1MBKIT	A808091	61
	2MBKIT	A808101	111
386SX, 20, 25 & 286 486SX/25+	1MBKIT	A808231	66
	2MBKIT	A908101	116
386SX/20 +	8MB KIT	A808631	600

EVEREX MEMORY

TEMPO LX	2MB MODULE	PCA-000053-00	$ 180
TEMPO LX20	2MBMODULE	PCA-000054-00	200
TEMPO286	512KKIT	N/A	40
	2MBKIT	N/A	125
TEMPO 386SX	1MBKIT	N/A	60
	2MBKIT	N/A	125
	4MBKIT	N/A	225
CACHE KIT	64K	N/A	70
286STEP 12, 16	1MBKIT	N/A	60
	2MB KIT	N/A	100
	4MBKIT	N/A	225
286 STEP 230	1MBKIT	N/A	60
	2MB KIT	N/A	100
	4MBKIT	N/A	225
386 STEP 16, 20, 25	1MBKIT	N/A	60
	2MBKIT	N/A	100
	4MBKIT	N/A	225
STEP 386/33	4MBMDL	N/A	225
	64KMDL	PWA-00582-00	230

HP VECTRA MEMORY

486PC, 486/33T/25T (INSTALL IN PAIRS) 486S/20	1MBSIMM	D2150A	$70
	2MBSIMM	D2381A	125
	4MBSIMM	D2156A	205
	8MBSIMM	D2125A	450
386QS25	2MBSIMM	D2381A	125
	8MBSIMM	D2125A	450
OS/16S & RS/20PC	1MBKIT	D1540A	65
OS/16S & ES/12PC	2MB KIT	D1354A	105
OS/16S & RS/20PC	4MBKIT	D1542A	215
OS/20PC & RS/25PC	1MBKIT	D1640A	65
	4MBKIT	D1642A	215
LS/12	1MBMODULE	D1054A	150
9000 SERIES 425E	4MBBDSET	A2200A	425
	8MBBDSET	A2201A	840
	16MBBDSET	A2202A	1,575
345, 375, 433S, 400S, 425T, 400DI, 400T	4MBBDSET	H98229C	425
	8MBBDSET	H98229B	840
	16MBBDSET	H98229D	1,575
	32MBBDSET	H98229E	3,250

LAPTOP MEMORY

BONDWELL			
B310 SUPERSLIM	1MBMODULE	23050-09100	$ 150
COMMODORE			
LAPTOP	2MB MODULE	390850-01	150
GOLDSTAR			
GS520 386SX/16	1MB MODULE	N/A	135
	4MB MODULE	N/A	350
LEADING EDGE			
DLT386SX	1MB MODULE	230509100	100
PACKARDBELL, MAGNAVOX & MITSUBA			
PB286NB	1MB MODULE	N/A	170
	4MB MODULE	N/A	395
PB386NBX	1MB MODULE	N/A	170
	2MB MODULE	N/A	205
	4MB MODULE	N/A	395
PANASONIC			
CF170/270/370 (INSTALL IN PAIRS)	1MBMODULE	CF-BA165	121
SAMSUNG			
NOTEMASTER 386S	2MB MODULE	SNM002	210
	4MBMODULE	SNM004	405
SANYO			
17/NB, 18/NB	2MBMODULE	MBC-NBMEM2	145
SHARP			
PC-6220	1MB MODULE	CE-6218	122
PC-6640	2MBKIT	N/A	195
PC-4700MZ-200	1MB MODULE	CE471	180
PC-8501 COLORSTAR	2MB MODULE	N/A	280
TANDON			
NB386SX	1MB MODULE	N/A	115
	4MB MODULE	N/A	270
TI			
TRAVELMATE 2000	1MB MODULE	2568034-0001	110
TRAVELMATE 3000	2MBKIT	2566996-0001	145

NEC MEMORY

POWERMATE SX PLUS	1-8MBBD	APC-H850E	$218
	1MBKIT	APC-H851E	66
	2MBBD	APC-H852E	255
	4-8MBBD	APC-H250E	415
	8MBBD	N/A	772
POWERMATE 386/16 & 20	4-16MBBD	N/A	766
	8-16MBBD	N/A	988
	16MBBD	N/A	1,322
POWERMATE/ BUSINESS 386/25S	4-16MBBD	N/A	527
	8-16MBBD	N/A	772
	16MBBD	N/A	1,250
POWERMATE/ BUSINESS 386/25S	2MBKIT	OP-410-5201	$150
	8MBKIT	OP-410-5202	422
POWERMATE SX/20	2MB MODULE	OP-410-8101	211
	2-8MBBD	OP-410-8102	240
	2MB KIT	OP-410-8103	140
POWERMATE SX/16	2-8MBBD	OP-410-8201	240
	2MBKIT	OP-410-8103	140
POWERMATE SX	2MBBD	APC-H855	527
	4-8MBBD	APC-H853	744
	8MBBD	N/A	1,222
POWERMATE 386/33E & 486/25E	2MBMODULE	OP-41-5101	225
POWERMATE PORTABLE SX	2MB MODULE	APC-H751X	327
	8MBMODULE	APC-H753X + H754X	1,166
ULTRALITE 286F	1MBMODULE	PC-22-21	185
	4MBMODULE	PC-22-22	495
ULTRALITE SX/20	2MBMODULE	PC-44-21	275
	8MBMODULE	PC-44-22	705
PROSPEED 286 & 386SX/16	1MB MODULE	PC-21-21	145
	4MB MODULE	PC-21-22	450
PROSPEED SX/20	1MBBD	PC-43-21	185
	4MBBD	PC-43-22	385
PRTOSPEED386	2MB	PC-31-21	200
	8MB	PC-31-22	875
POWERMATE PORTABLE PLUS	1-3MBBD	APC-H750U	385
	2-3MBBD	H750+751	395
	3MBBD	750+(2)751	495

NCR MEMORY

PC286, ELPC386SX	2MBKIT	3302-K102	$162
NCREXPBD	2MBKIT	3279-K119	162
PC386SX/20	1MBKIT	3304-K105	102
	2MB KIT	3304-K106	162
	8MBKIT	3304-K107	630
PC386SX/MC20	2MB MODULE	3421-K202	180
	2-14MBEXPBD	N/A	270
	4-14MBEXPBD	N/A	366
PC486/MC25	2MBKIT	3314-K102	300
	8MB KIT	3314-K104	570
	2-14MBEXPBD	N/A	288
	4-14MBEXPBD	N/A	384

ZENITH MEMORY

Z486/33ET	4MB MODULE	ZA4200-M2	$225
	16MBKIT	ZA4200-M8	999
Z386/33 & 33E	1MB MODULE	ZA3800ME	75
	2MB MODULE	ZA3800MG	115
486/25E	4MB MODULE	ZA3800MK	220
Z386/25, 20	1MB MODULE	ZA3600ME	54
	2MB MODULE	ZA3800MG	115
	4MB MODULE	ZA3800MK	210
Z248, Z286LP, ZLS Z386SX	2MB MODULE	Z-605-1	120
TURBOSPORT 386E	1MBMODULE	ZA3034ME	170
	4MBMODULE	ZA3035ME	495
SUPERSPORT SX	2MB MODULE	ZA180-64	185
	2MB MODULE	ZA180-86	185
	2MB MODULE	ZA180-87	185
SUPERSPORT 286, 286E	1MB MODULE	ZA180-66	$120
	2MB MODULE	ZA180-64	185
286E ONLY	4MB MODULE	ZA180-71	425
286 ONLY	4MB MODULE	ZA180-67	CALL
SLIMSPORT	1MB MODULE	ZA180-95	185
	2MB MODULE	ZA180-64	185
	4MB MODULE	ZA180-71	390
MASTERSPORT 286	1MBMODULE	ZA-212-1	145
MASTERSPORT SL, SLC 386SX	2MB MODULE	ZA-4-4	215
	2MB MODULE	ZA-360-1	215

LASER PRINTER

SUPERSPORT 286, 286E	1MB MODULE	ZA180-66	$120
	2MB MODULE	ZA180-64	185
286E ONLY	4MB MODULE	ZA180-71	425
286 ONLY	4MB MODULE	ZA180-67	CALL
SLIMSPORT	1MB MODULE	ZA180-95	185
	2MB MODULE	ZA180-64	185
	4MB MODULE	ZA180-71	390
MASTERSPORT 286	1MBMODULE	ZA-212-1	145
MASTERSPORT SL, SLC 386SX	2MB MODULE	ZA-4-4	215
	2MBMODULE	ZA-360-1	215
BROTHER HL-4	1-4MBMODULE	N/A	$150
BROTHER HL-8	1-4MBMODULE	N/A	150
CANON LBP 811, 811R, 811T	1MB MODULE	S63-1300	120
	2MB MODULE	S63-1880	155
	4MBMODULE	N/A	255
LBP 811 & 811 PLUS	1MBBD	S63-2340	175
	2MBBD	S63-2350	295
	3MBBD	S63-2360	395
LBP-4 & 4PLUS	1MBBD	S63-2240	195
	2MBBD	N/A	315
	1MBMODULE	S63-2230	195
EPSON EPL-6000	1MB MODULE	N/A	140
	2MB MODULE	N/A	190
	4MB MODULE	N/A	295
COMPATIBLE WITH: TOSHIBA PAGELASER 6, MANNESMANN TALLY 905, PHILLIPS NMS 1480, EVEREX, ESSELTE T-6 HARRIS/3M, C-ITOH C1-5, ATARI SLM-804 PCV OASYS, NCR 6436, LANEAR, FACIT P6060 PACKARD BELL PB9600			
EPL7000	1MB MODULE	N/A	110
	2MB MODULE	C822011	195
	3MBMODULE	N/A	230
FUJITSU RX7100 & 7200N	1MB MODULE	N/A	225
	2MB MODULE	N/A	295
HP DESKJET PLUS500	256KMODULE	N/A	114
HP LASERJET IIISI	1MBMODULE	C2063A	75
	4MB MODULE	C2065A	195
II & IID	2MB MODULE	33444B	140
	4MBMODULE	33445B	250
IIP, IIID, IIIP, III P7550	1MBMODULE	33474B	85
	2MBMODULE	33475B	140
	4MB MODULE	N/A	250
KONICA	1-3MBMODULE	3110	150
NEC SILENTWRITER MDL 90, 290	2MBMODULE	4892	175
OLIVETTI PG-108 & PG-208	1-4MB	N/A	115
KYOCERA F800/A/T	1,2,4MB	N/A	140
F1200S/F3300/A	1-4MB	N/A	155
F820, F-1800/A F-5000	1MBSIMM	N/A	120
OKIDATA LASER-400	1MBMODULE	70014701	118
LASER-800	1MB MODULE	N/A	135
	2MBMODULE	N/A	185
	4MBMODULE	N/A	290
PANASONIC KX-P4420/4450I	1MB MODULE	KXP-443/286209	135
	2MBMODULE	KXP-441/286210	180
	3MB MODULE	N/A	225
	4MBMODULE	N/A	280
4450	1MBMODULE	N/A	169
4455	1-2MBMODULE	N/A	130
QMS-PS410	1-4MBMODULE	N/A	150
SHARP 9500PS	1MBMODULE	N/A	95
STARLASER 4	1,2,4MB MODULE	N/A	120
STARLASER 8	1,2,4MB MODULE	N/A	CALL
TI MICROLASER	1MBMODULE	N/A	85
	2MBKIT	N/A	175
	3MBKIT	N/A	270
	4MBKIT	N/A	350
TEC LB1321C C-ITOH-4 MANNESMANN TALLY 904	1MN SIMM	N/A	120

If you find a better price, call us before you buy!

MOTHER BOARDS

MOTHER BOARDS PRICES ARE NEGOTIABLE WHEN PURCHASED WITH CPU & MEMORY.

ONE BOARD SOLUTION

PA486-SMT-20/25/33/DX2 & PA386-SMT-25/33
486DX/486SX/386DX 64KB/256KB CACHE

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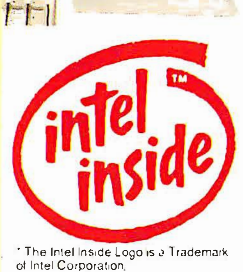
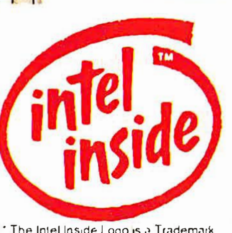
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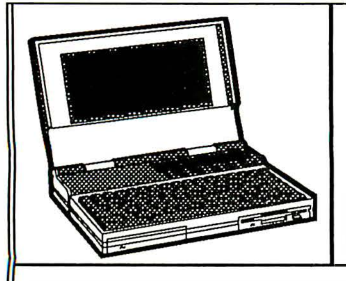
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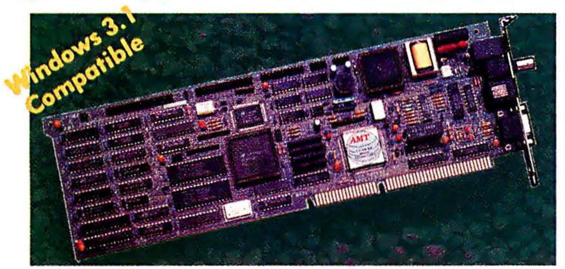
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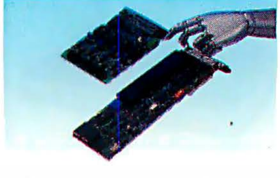
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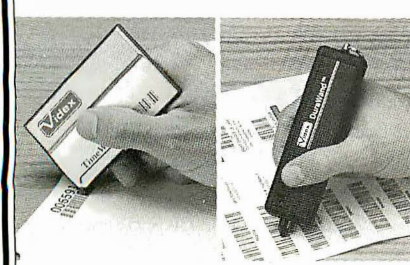


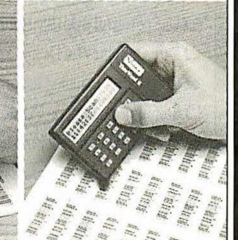
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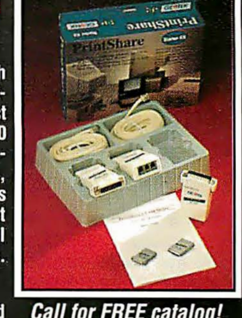
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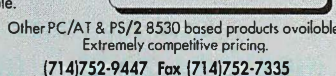
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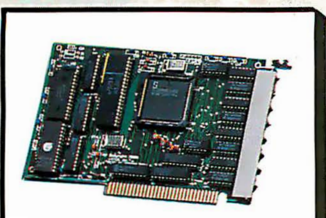
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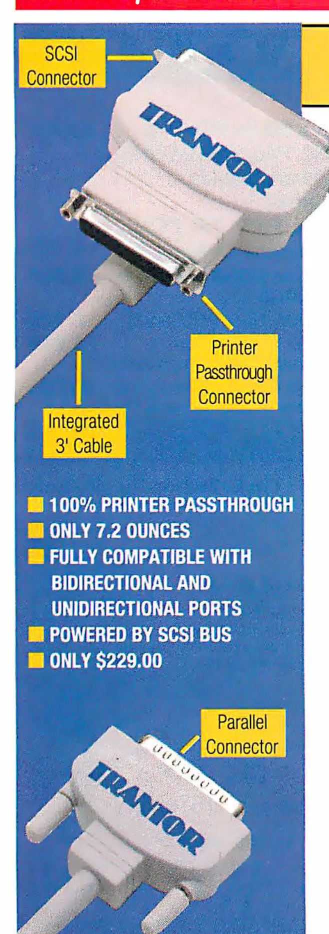
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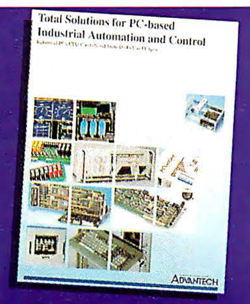
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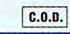
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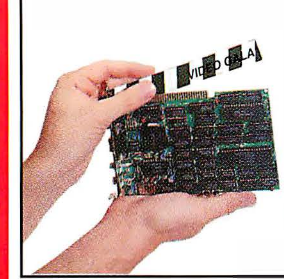
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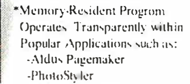
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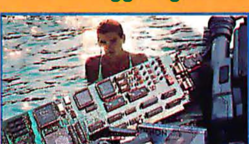
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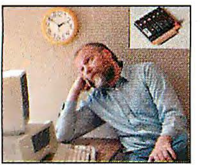
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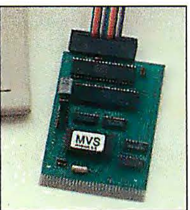
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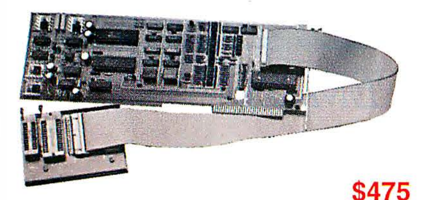
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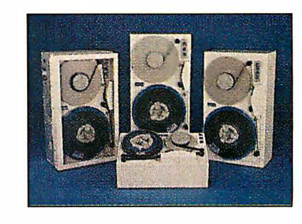
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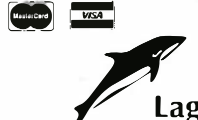
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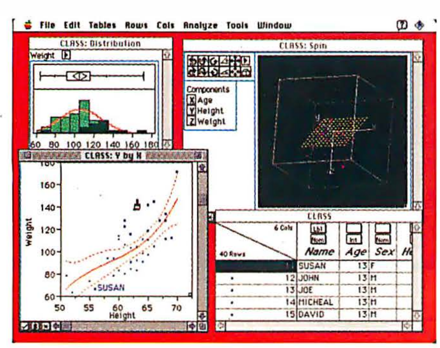


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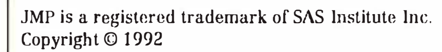
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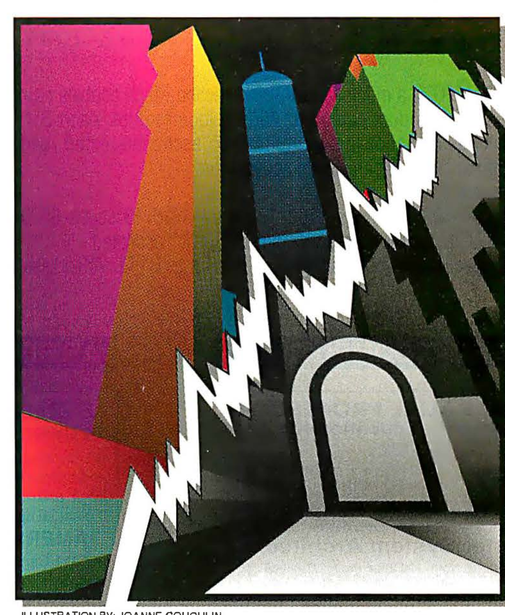


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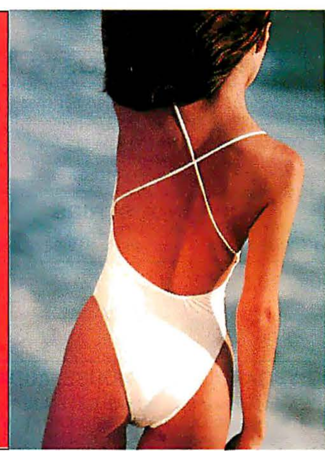
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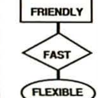
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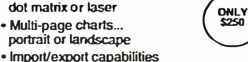
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371	BLACKWELL S/W	268IS-3	44-0865-721205
393	BLINK INC	259	804-355-4444
330-331	BORLAND INT'L (INT'L)	CIV	800-331-0877
83-84	BORLAND INT'L	17	800-331-0877
85-86	BORLAND INT'L	18,19	800-331-0877
388	BOSTON UNIV ED CTR	306	508-649-4200
322	BRENT COMMNCTNS	178UK-4	44-0423-501-44
399	BUFFALO PRODUCTS	35	800-345-2356
208	BULLDOG COMP PROD	337	800-438-6039
*	BUYER'S MART	112IS-7,8	603-924-2656
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89	CAPITAL EQUIPMENT CO	185	800-234-4232
314-315	CHAI SHIN	354	886-2-9619586**
234	CITITRONICS	332	818-855-5688
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91	COMPUCLASSIC	244	800-827-1994
384	COMPUDYNE	236,237	800-932-COMP
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209	COMPUTERLANE UNLTD	342	800-526-3482
253	COMPUTERWISE	361	800-255-3739
230-231	COMTRADE	349	800-689-2123
*	COPIA INT'L	146	708-682-8898
339-340	CORE INT'L	162IS-1	407-997-6044
96	COREL SOFTWARE	40	800-836-SCSI
327	CORPORATE ITEC SERVICES	178UK-4	44-0793-611-43
195	CREATIVE LABS INC	271	800-998-LABS
97	CURTIS INC	284	612-631-9512
395-397	CYBER RESEARCH	344	800-394-3300
210	CYBEXCORP	338	205-534-0010**
223	CYBEX CORP (INT'L)	CIII	205-534-0010**
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312-313	DAVISON-WORTH CORP	358	800-668-2707
87	DECISIONS	375	
100	DELL COMP CORP (N.A.)	CIII	800-626-8260
101	DELL COMP CORP (N.A.)	CIV	800-626-8260
102	DELL COMP CORP (N.A.)	36,37	800-626-8260
63	DELL COMPUTER CORP (N.A.)	218,219,221	800-626-8260
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*	ELONEX (INT'L)	177	44-81-452-6422
214	ELTECH RESEARCH	345	800-358-8330
307	EMPIRE COMPUTECH	358	800-446-1967
342	EUTRON	284IS-1	39-35-692-229**

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345	GREY MATTER LTD	146IS-2	44-0364-53071**
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*	INTEL CORP	81	800-538-3373
121	INTEL CORP	99	800-538-3373
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127	MICROGRAFX	141	800-733-3729
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129	MICROWAY	272	
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140	MINUTEMAN	121	214-446-7363
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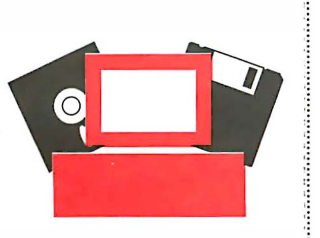
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1311	1336	1361	1386	1411	1436	1461
1312	1337	1362	1387	1412	1437	1462
1313	1338	1363	1388	1413	1438	1463
1314	1339	1364	1389	1414	1439	1464
1315	1340	1365	1390	1415	1440	1465
1316	1341	1366	1391	1416	1441	1466
1317	1342	1367	1392	1417	1442	1467
1318	1343	1368	1393	1418	1443	1468
1319	1344	1369	1394	1419	1444	1469
1320	1345	1370	1395	1420	1445	1470
1321	1346	1371	1396	1421	1446	1471
1322	1347	1372	1397	1422	1447	1472
1323	1348	1373	1398	1423	1448	1473
1324	1349	1374	1399	1424	1449	1474
1325	1350	1375	1400	1425	1450	1475
1326	1351	1376	1401	1426	1451	1476
1327	1352	1377	1402	1427	1452	1477
1328	1353	1378	1403	1428	1453	1478
1329	1354	1379	1404	1429	1454	1479

YOUR DIRECT LINK CARD

For free product information, mail your completed card today. For quicker response, fax to 1-413-637-4343!

See reverse side for card.

1. Circle the Numbers on Your Direct Link Card

Circle the numbers which are found on ads and articles in this issue or circle the product category number and receive information on all advertisers listed in that category.

2. Print Your Name and Address

Answer questions "A" through "E" and mail or fax card to 1-413-637-4343.

3. Product information will be rushed to you from the selected companies!





BUSINESS REPLY MAIL

FIRST CLASS MAIL PERMIT NO. 176 PITTSFIELD, MA

POSTAGE WILL BE PAID BY ADDRESSEE

BYTE

READER SERVICE
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Pittsfield, MA 01203-9926
USA

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

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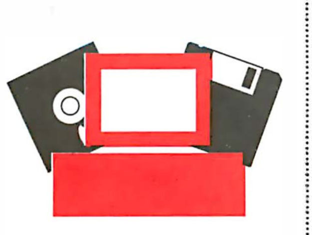
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Answer questions "A" through "E" and mail or fax card to 1-413-637-4343.

3. Product information will be rushed to you from the selected companies!





Yes, I want FREE information on the following products!

Fill out this coupon carefully. ***Please Print.***

Name ______________________

Title ______________________

Company ______________________

Address ______________________

City ______________ State ________ Zip ________

Phone ______________ Fax ______________

A. What is your primary job function/principal area of responsibility? (Check one)
1 ❑ MIS/DP
2 ❑ Programmer/Systems Analyst
3 ❑ Administration/Management
4 ❑ Sales/Marketing
5 ❑ Engineer/Scientist
6 ❑ Other

B. What is your level of management responsibility?
7 ❑ Senior-level
9 ❑ Professional
8 ❑ Middle-level

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?
10 ❑ Yes
11 ❑ No

D. What operating systems are you currently using? (Check all that apply)
12 ❑ PC/MS-DOS
15 ❑ Unix
13 ❑ DOS + Windows
16 ❑ MacOS
14 ❑ OS/2
17 ❑ VAX/VMS

E. For how many people do you influence the purchase of hardware or software?
18 ❑ 1-25
20 ❑ 51-99
19 ❑ 26-50
21 ❑ 100 or more

❑ Please send me one year of BYTE Magazine for $24.95 and bill me. Offer valid in U.S. and possessions only.

September 1992 *89 96 99*

Product Category Information

Circle the numbers below for information on the entire category of products you're interested in.

Category	No.
Hardware	
Accessories/Supplies	1
Add-in Boards	2
Bar Coding	3
Communications/Networking	4
Computer Systems	5
Data Acquisition	6
Disks & Optical Drives	7
Diskettes/Duplicators	8
Fax Boards/Machines	9
Graphics Tablets/Mice/ Pen Input	10
Keyboards	11
LAN Hardware	12
Laptops & Notebooks	13
Mail Order	14
Memory/Chips/Upgrades	15
Miscellaneous Hardware	16
Modems/Multiplexors	17
Monitors & Terminals	18
Multimedia	19
Printers/Plotters	20
Programmable Hardware	21
Scanners/OCR/Digitizers	22
Tape Drives	23
UPS	24
Software	
Business	25
CAD/CAM	26
Communications/Networking	27
Data Acquisition	28
Database	29
Educational	30
Engineering/Scientific	31
Entertainment	32
Graphics	33
Macintosh	34
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Shareware	42
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56	82	108	134	160	186	212
57	83	109	135	161	187	213
58	84	110	136	162	188	214
59	85	111	137	163	189	215
60	86	112	138	164	190	216
61	87	113	139	165	191	217
62	88	114	140	166	192	218
63	89	115	141	167	193	219
64	90	116	142	168	194	220
65	91	117	143	169	195	221
66	92	118	144	170	196	222
67	93	119	145	171	197	223
68	94	120	146	172	198	224
69	95	121	147	173	199	225
70	96	122	148	174	200	226
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74	100	126	152	178	204	230
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409	435	461	487	513	539	565
410	436	462	488	514	540	566
411	437	463	489	515	541	567
412	438	464	490	516	542	568
413	439	465	491	517	543	569
414	440	466	492	518	544	570
415	441	467	493	519	545	571
416	442	468	494	520	546	572
417	443	469	495	521	547	573
418	444	470	496	522	548	574
419	445	471	497	523	549	575
420	446	472	498	524	550	576
421	447	473	499	525	551	577
422	448	474	500	526	552	578
423	449	475	501	527	553	579
424	450	476	502	528	554	580
425	451	477	503	529	555	581
426	452	478	504	530	556	582
427	453	479	505	531	557	583
428	454	480	506	532	558	584
429	455	481	507	533	559	585
430	456	482	508	534	560	586
431	457	483	509	535	561	587
432	458	484	510	536	562	588
433	459	485	511	537	563	589
434	460	486	512	538	564	590

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766	792	818	844	870	896	922
767	793	819	845	871	897	923
768	794	820	846	872	898	924
769	795	821	847	873	899	925
770	796	822	848	874	900	926
771	797	823	849	875	901	927
772	798	824	850	876	902	928
773	799	825	851	877	903	929
774	800	826	852	878	904	930
775	801	827	853	879	905	931
776	802	828	854	880	906	932
777	803	829	855	881	907	933
778	804	830	856	882	908	934
779	805	831	857	883	909	935
780	806	832	858	884	910	936
781	807	833	859	885	911	937
782	808	834	860	886	912	938
783	809	835	861	887	913	939
784	810	836	862	888	914	940
785	811	837	863	889	915	941
786	812	838	864	890	916	942
787	813	839	865	891	917	943
788	814	840	866	892	918	944
789	815	841	867	893	919	945
790	816	842	868	894	920	946
791	817	843	869	895	921	947

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1123	1149	1175	1201	1227	1253	1279
1124	1150	1176	1202	1228	1254	1280
1125	1151	1177	1203	1229	1255	1281
1126	1152	1178	1204	1230	1256	1282
1127	1153	1179	1205	1231	1257	1283
1128	1154	1180	1206	1232	1258	1284
1129	1155	1181	1207	1233	1259	1285
1130	1156	1182	1208	1234	1260	1286
1131	1157	1183	1209	1235	1261	1287
1132	1158	1184	1210	1236	1262	1288
1133	1159	1185	1211	1237	1263	1289
1134	1160	1186	1212	1238	1264	1290
1135	1161	1187	1213	1239	1265	1291
1138	1162	1188	1214	1240	1266	1292
1137	1183	1189	1215	1241	1267	1293
1138	1164	1190	1216	1242	1268	1294
1139	1165	1191	1217	1243	1269	1295
1140	1166	1192	1218	1244	1270	1296
1141	1167	1193	1219	1245	1271	1297
1142	1168	1194	1220	1246	1272	1298
1143	1169	1195	1221	1247	1273	1299
1144	1170	1196	1222	1248	1274	1300
1145	1171	1197	1223	1249	1275	1301
1146	1172	1198	1224	1250	1276	1302
1147	1173	1199	1225	1251	1277	1303
1148	1174	1200	1226	1252	1278	1304

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235	260	285	310	335	360	385
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238	263	288	313	338	363	388
239	264	289	314	339	364	389
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241	266	291	316	341	366	391
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243	268	293	318	343	368	393
244	269	294	319	344	369	394
245	270	295	320	345	370	395
246	271	296	321	346	371	396
247	272	297	322	347	372	397
248	273	298	323	348	373	398
249	274	299	324	349	374	399
250	275	300	325	350	375	400
251	276	301	326	351	376	401
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254	279	304	329	354	379	404
255	280	305	330	355	380	405
256	281	306	331	356	381	406
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258	283	308	333	358	383	408

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592	617	642	667	692	717	742
593	618	643	668	693	718	743
594	619	644	669	694	719	744
595	620	645	670	695	720	745
596	621	646	671	696	721	746
597	622	647	672	697	722	747
598	623	648	673	698	723	748
599	624	649	674	699	724	749
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601	626	651	676	701	726	751
602	627	652	677	702	727	752
603	628	653	678	703	728	753
604	629	654	679	704	729	754
605	630	655	680	705	730	755
806	631	656	681	706	731	756
607	632	657	682	707	732	757
608	633	658	683	708	733	758
609	634	659	684	709	734	759
610	635	660	685	710	735	760
611	636	661	686	711	736	761
612	637	662	687	712	737	762
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614	639	664	689	714	739	764
615	640	665	690	715	740	765

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949	974	999	1024	1049	1074	1099
950	975	1000	1025	1050	1075	1100
951	976	1001	1026	1051	1076	1101
952	977	1002	1027	1052	1077	1102
953	978	1003	1028	1053	1078	1103
954	979	1004	1029	1054	1079	1104
955	980	1005	1030	1055	1080	1105
956	981	1006	1031	1056	1081	1106
957	982	1007	1032	1057	1082	1107
958	983	1008	1033	1058	1083	1108
959	984	1009	1034	1059	1084	1109
980	985	1010	1035	1060	1085	1110
961	986	1011	1036	1061	1086	1111
962	987	1012	1037	1062	1087	1112
963	988	1013	1038	1063	1088	1113
964	989	1014	1039	1064	1089	1114
965	990	1015	1040	1065	1090	1115
966	991	1016	1041	1066	1091	1116
967	992	1017	1042	1067	1092	1117
968	993	1018	1043	1068	1093	1118
969	994	1019	1044	1069	1094	1119
970	995	1020	1045	1070	1095	1120
971	996	1021	1046	1071	1096	1121
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1306	1331	1356	1381	1406	1431	1456
1307	1332	1357	1382	1407	1432	1457
1308	1333	1358	1383	1408	1433	1458
1309	1334	1359	1384	1409	1434	1459
1310	1335	1360	1385	1410	1435	1460
1311	1336	1361	1386	1411	1436	1461
1312	1337	1362	1387	1412	1437	1462
1313	1338	1383	1388	1413	1438	1483
1314	1339	1364	1389	1414	1439	1464
1315	1340	1365	1390	1415	1440	1465
1316	1341	1366	1391	1416	1441	1466
1317	1342	1367	1392	1417	1442	1467
1318	1343	1368	1393	1418	1443	1468
1319	1344	1369	1394	1419	1444	1469
1320	1345	1370	1395	1420	1445	1470
1321	1346	1371	1396	1421	1446	1471
1322	1347	1372	1397	1422	1447	1472
1323	1348	1373	1398	1423	1448	1473
1324	1349	1374	1399	1424	1449	1474
1325	1350	1375	1400	1425	1450	1475
1326	1351	1376	1401	1426	1451	1476
1327	1352	1377	1402	1427	1452	1477
1328	1353	1378	1403	1428	1453	1478
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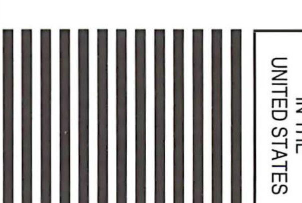
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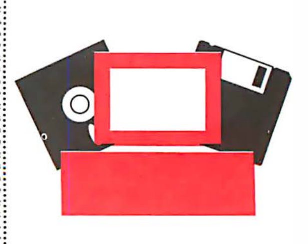
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YOUR DIRECT LINK

PRODUCT CATEGORY INDEX

For FREE product information from individual advertisers, circle the corresponding inquiry numbers on your Direct Link Card!

To receive information for an entire product category, circle the category number on your Direct Link Card!

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Decisions, decisions, decisions.



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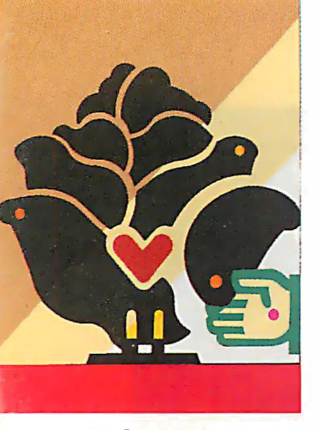
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STOP BIT

NOLAN BUSHNELL

The Artichoke Theory

In the beginning, we were the gigafreaks, nerds, and dweebs. We thought Pascal was a romance language, and we all had girlfriends named Ada. We read BYTE and loved those intricate line drawings, which we discussed at Homebrew and the Boston Computer Society. We spawned the PC revolution, and we began it by meeting and selling products to each other. But we didn't get rich until we figured out how to sell the stuff to the "others."

Why not tailor the user interface to each user's ability level? I call this the artichoke approach.

The others were not computer champs. They were people who wore white socks only with running shoes. They were people with "real" jobs who used PCs not for the sheer joy of it, but for solving problems at work. They hated user's manuals thicker than unabridged dictionaries. They found the dot prompt user-hostile. Nevertheless, they were willing to climb that steep learning curve for the productivity benefits offered by products like dBase and VisiCalc. Times have changed.

Twenty years ago, I created a computer interface that was so easy to use that people understood how to operate my program within 15 seconds. The interface was so compelling that people were willing to pay 25 cents every few minutes for the excitement of using it. It was called Pong, and it started Atari.

My contribution to the PC revolution was in trying to make computers easy to use and compel millions of people to play. To some degree, that has happened. But it has not gone nearly as far as I had hoped.

The PC cannot be mastered in 15 seconds. It still isn't as easy to use as a toaster or TV. And when I think of all the aspects of new technology—networking, voice-mail, E-mail, fax, and video—I fear that things may be getting more difficult.

Go to Comdex and walk the floor. Everyone is jabbering about tying together all aspects of automation. To use the stuff, all one needs is an E.E. degree from MIT. To install it, one needs about five consultants. And to afford it, one needs to float junk bonds on the house, business, wife, and kids. Then, the E-mail, LAN, PCs, telephone, video, fax, peripherals, and so on probably won't be compatible. And even if they are, it's going to take a few hundred years to actually get them to work together and to learn how to use them. No wonder the industry hit a slump.

The problem goes beyond simply providing an easy-to-use product. Different people—from the receptionist to the MIS manager to the CEO—have different needs to know the many aspects of integrated or unified systems. And they each have different desires to understand it. Yet we force them all to use the same interface.

Why can't we technologists assemble a multidimensional interface system? Why not let those who have the greatest fear and the least time to learn deal with just the outer level of a complex system? Let the technologists in an organization have access to the depth and complexity. I call this configuration the artichoke approach.

The complexity of the technology may be a joy to the gigafreak, but it is an intimidating nightmare to the others. We need to make all of it run so easily that even a CEO can comprehend how to use the system productively. I am only partly joking. CEOs are the busiest people in an organization, and they have less time to learn new things than anyone else. If a CEO is not part of a unified automation system, then that automation system will not truly be the spine of the organization.

How do we take this incredible complexity and present it so that everyone is empowered to use it? With games, we tell the machine our level of expertise. Why not with networked office systems?

The interface can best be described as a great electronic artichoke. At its heart is a complex mass of technology in which the systems integrator can feast. At the outer leaf is a system so easy to use that even a CEO will partake.

The CEO can learn the outer leaf of this electronic artichoke in 30 seconds. Once the user learns and digests the first leaf, the next leaf can be taken, digested and understood, and so on, until he or she readily understands all the capabilities at its heart.

The key to true ease of use is to make the front end enjoyable, easy, nonintimidating, and intuitive. The value of the system should be apparent. Everyone should want to take the next bite. ■

Nolan Bushnell is the founder of Atari and inventor of Pong, the world's first video game. He is currently chairman of OCTuS, a communications server vendor in San Diego. You can reach him on BIX c/o "editors."

Stop Bit is a forum for informed opinion on personal computing topics. The opinions expressed are those of the author and not necessarily those of BYTE. Your contributions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

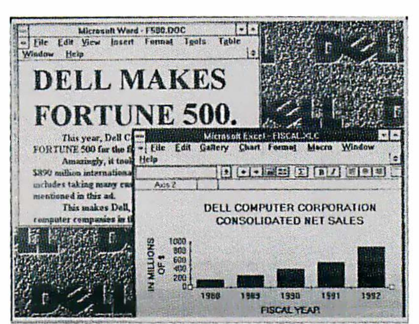
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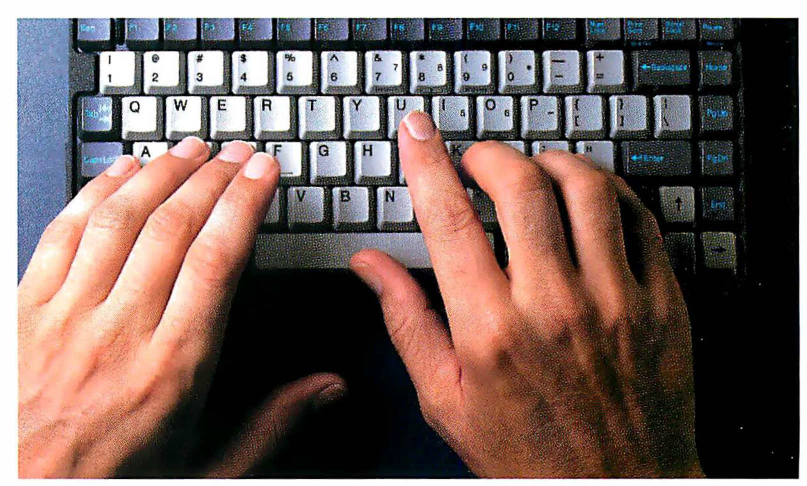
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